Intel® Xeon® Processor 5500 Series

Thermal/Mechanical Design Guide

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Revision History

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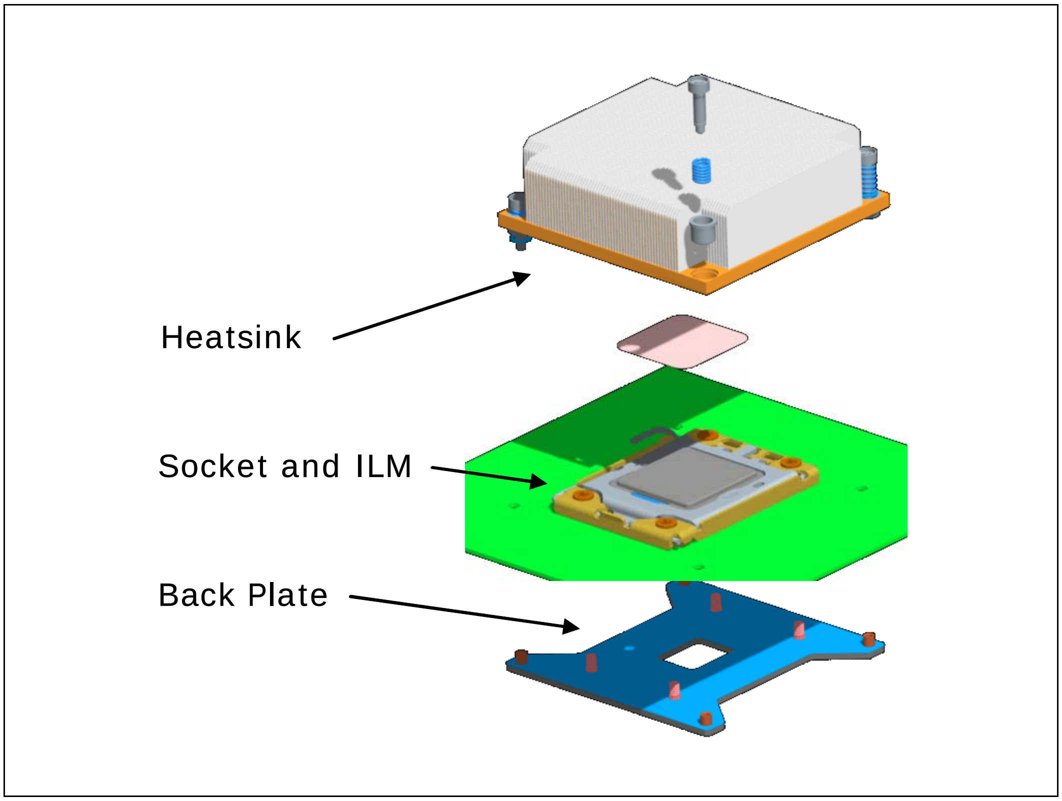
1 Introduction

This document provides guidelines for the design of thermal and mechanical solutions for 2-socket server and 2-socket Workstation processors in the Intel® Xeon® 5500 Platform. The processors covered include those listed in the *Intel® Xeon® Processor 5500 Series Datasheet*, *Volume 1* and the follow-on processors. The design guidelines apply to the follow-on processors in their current stage of development and are not expected to change as they mature. The components described in this document include:

- The processor thermal solution (heatsink) and associated retention hardware.
- The LGA1366 socket and the Independent Loading Mechanism (ILM) and back plate.

Processors in 1-socket Workstation platforms are covered in the Intel® Xeon® Processor 3500 Series Thermal/Mechanical Design Guide.

Figure 1-1. Intel® Xeon® 5500 Platform Socket Stack



The goals of this document are:

- To assist board and system thermal mechanical designers.
- To assist designers and suppliers of processor heatsinks.

Thermal profiles and other processor specifications are provided in the Datasheet.

1.1 References

Material and concepts available in the following documents may be beneficial when reading this document.

Table 1-1. Reference Documents

Document	Location	Notes
European Blue Angel Recycling Standards		2
Intel® Xeon® Processor 5500 Series Datasheet, Volume 1	321321	1
Intel® Xeon® Processor 5500 Series Mechanical Model	321326	1
Intel® Xeon® Processor 5500 Series Thermal Model	321327	1
Entry-level Electronics Bay Specification		3

Notes:
1. Document numbers indicated in Location column are subject to change. See the appropriate Electronic Design Kit (EDK) for the most up-to-date Document number.
2. Available at http://www.blauer-engel.de
3. Available at http://ssiforum.oaktree.com/

1.2 Definition of Terms

Table 1-2. Terms and Descriptions (Sheet 1 of 2)

Term	Description
Bypass	Bypass is the area between a passive heatsink and any object that can act to form a duct. For this example, it can be expressed as a dimension away from the outside dimension of the fins to the nearest surface.
DTS	Digital Thermal Sensor reports a relative die temperature as an offset from TCC activation temperature.
FSC	Fan Speed Control
IHS	Integrated Heat Spreader: a component of the processor package used to enhance the thermal performance of the package. Component thermal solutions interface with the processor at the IHS surface.
ILM	Independent Loading Mechanism provides the force needed to seat the 1366-LGA land package onto the socket contacts.
LGA1366 socket	The processor mates with the system board through this surface mount, 1366-contact socket.
PECI	The Platform Environment Control Interface (PECI) is a one-wire interface that provides a communication channel between Intel processor and chipset components to external monitoring devices.
Ψ_{CA}	Case-to-ambient thermal characterization parameter (psi). A measure of thermal solution performance using total package power. Defined as ($T_{CASE} - T_{LA}$) / Total Package Power. Heat source should always be specified for Ψ measurements.
Ψ_{CS}	Case-to-sink thermal characterization parameter. A measure of thermal interface material performance using total package power. Defined as ($T_{CASE} - T_S$) / Total Package Power.
Ψ_{SA}	Sink-to-ambient thermal characterization parameter. A measure of heatsink thermal performance using total package power. Defined as ($T_S - T_{LA}$) / Total Package Power.
T_{CASE}	The case temperature of the processor measured at the geometric center of the topside of the IHS.
T_{CASE_MAX}	The maximum case temperature as specified in a component specification.
TCC	Thermal Control Circuit: Thermal monitor uses the TCC to reduce the die temperature by using clock modulation and/or operating frequency and input voltage adjustment when the die temperature is very near its operating limits.

Table 1-2. Terms and Descriptions (Sheet 2 of 2)

Term	Description
$T_{CONTROL}$	$T_{CONTROL}$ is a static value below TCC activation used as a trigger point for fan speed control.
TDP	Thermal Design Power: Thermal solution should be designed to dissipate this target power level. TDP is not the maximum power that the processor can dissipate.
Thermal Monitor	A power reduction feature designed to decrease temperature after the processor has reached its maximum operating temperature.
Thermal Profile	Line that defines case temperature specification of a processor at a given power level.
TIM	Thermal Interface Material: The thermally conductive compound between the heatsink and the processor case. This material fills the air gaps and voids, and enhances the transfer of the heat from the processor case to the heatsink.
T_{LA}	The measured ambient temperature locally surrounding the processor. The ambient temperature should be measured just upstream of a passive heatsink or at the fan inlet for an active heatsink.
T_{SA}	The system ambient air temperature external to a system chassis. This temperature is usually measured at the chassis air inlets.
U	A unit of measure used to define server rack spacing height. 1U is equal to 1.75 in, 2U equals 3.50 in, etc.

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2 LGA1366 Socket

This chapter describes a surface mount, LGA (Land Grid Array) socket intended for processors in the Intel® Xeon® 5500 Platform. The socket provides I/O, power and ground contacts. The socket contains 1366 contacts arrayed about a cavity in the center of the socket with lead-free solder balls for surface mounting on the motherboard.

The socket has 1366 contacts with 1.016 mm X 1.016 mm pitch (X by Y) in a 43x41 grid array with 21x17 grid depopulation in the center of the array and selective depopulation elsewhere.

The socket must be compatible with the package (processor) and the Independent Loading Mechanism (ILM). The design includes a back plate which is integral to having a uniform load on the socket solder joints. Socket loading specifications are listed in Chapter 4.

Figure 2-1. LGA1366 Socket with Pick and Place Cover Removed

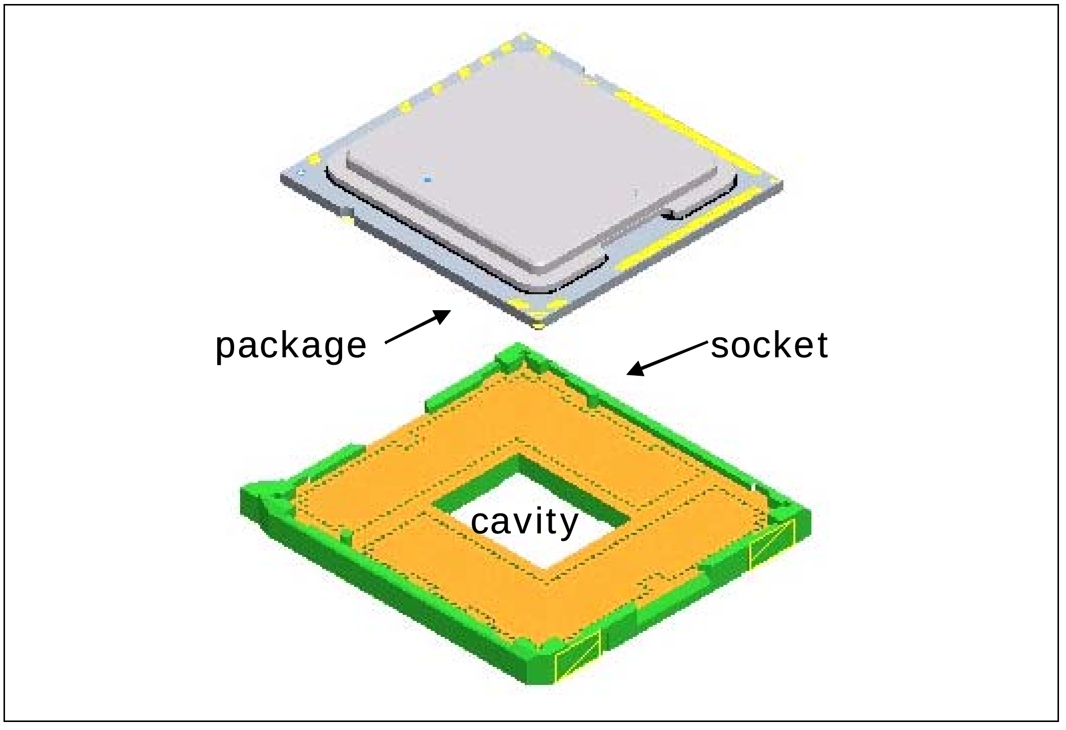
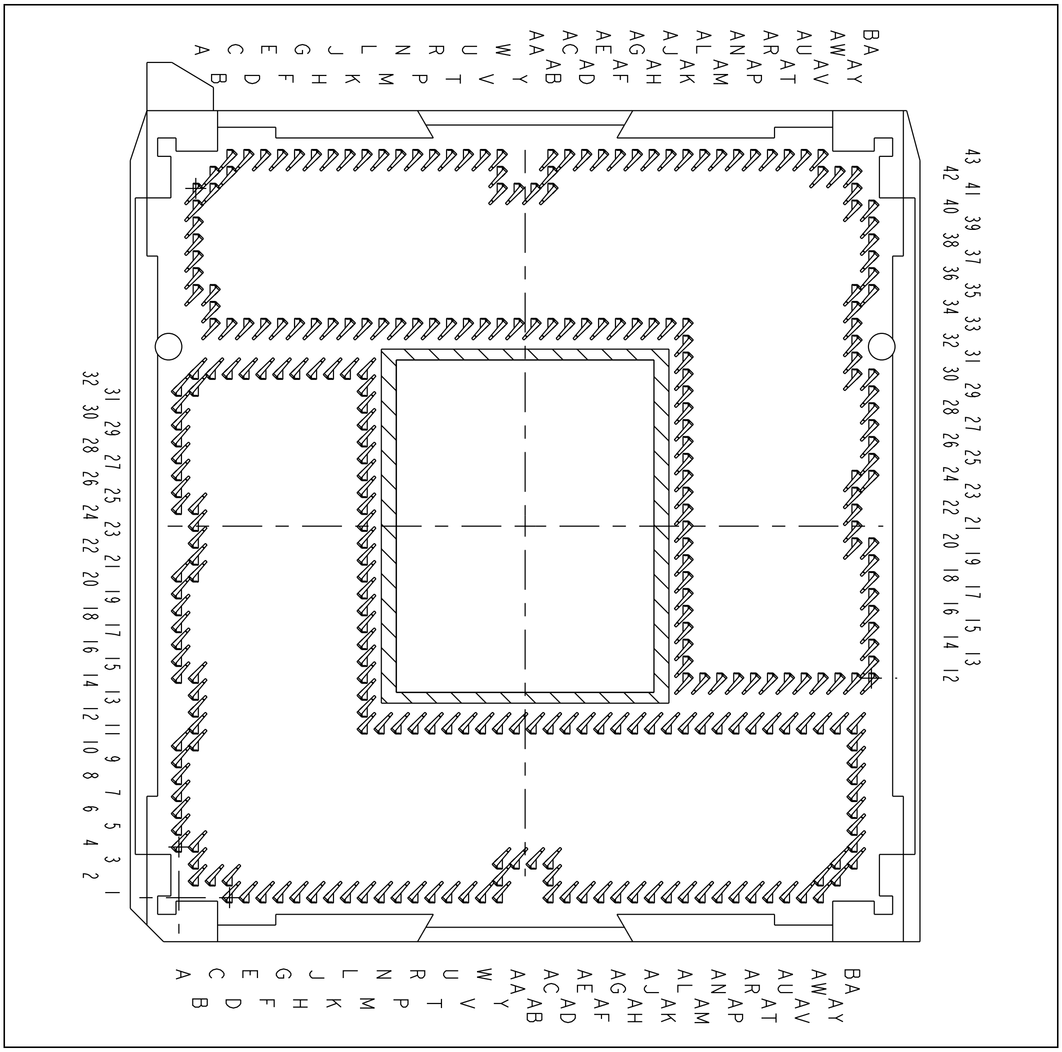


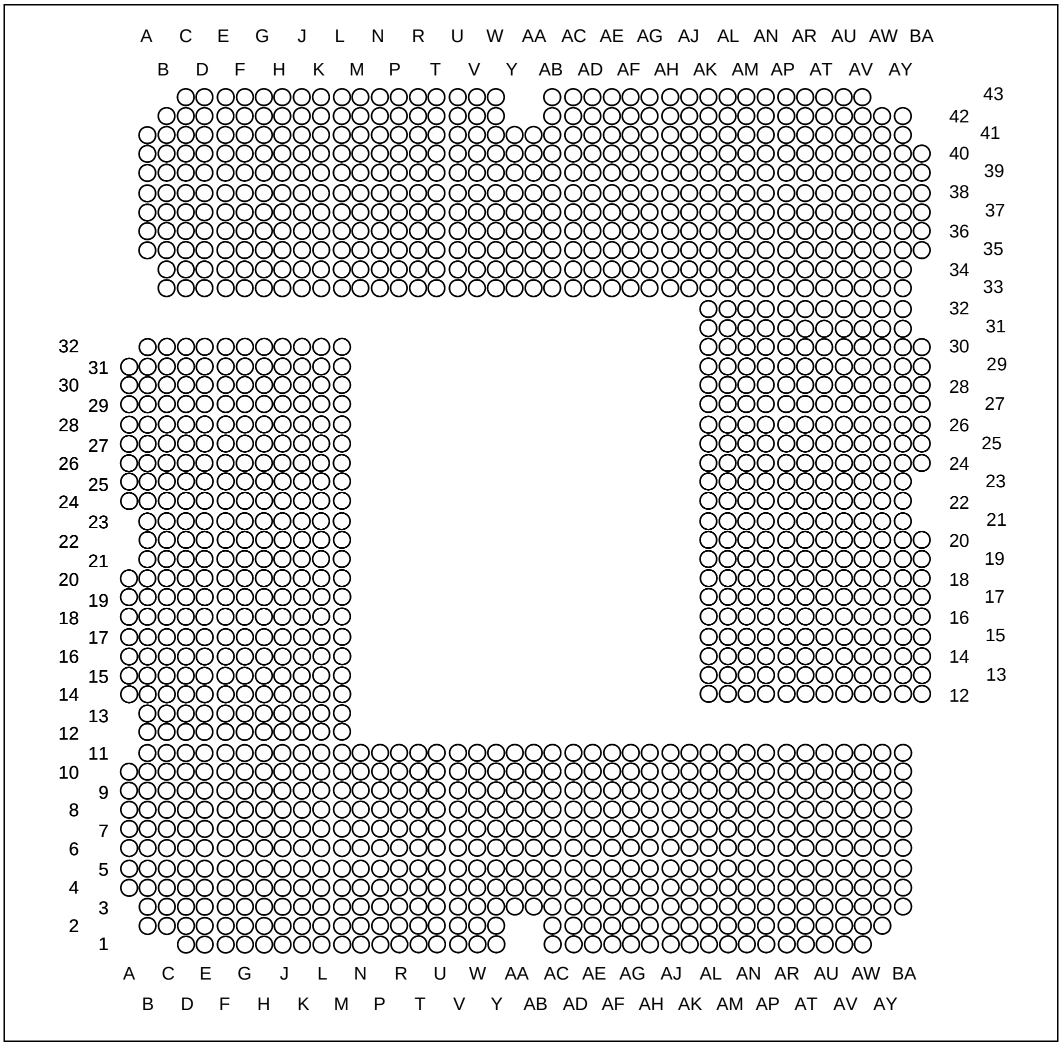
Figure 2-2. LGA1366 Socket Contact Numbering (Top View of Socket)



2.1 Board Layout

The land pattern for the LGA1366 socket is 40 mils X 40 mils (X by Y), and the pad size is 18 mils. Note that there is no round-off (conversion) error between socket pitch (1.016 mm) and board pitch (40 mil) as these values are equivalent.

Figure 2-3. LGA1366 Socket Land Pattern (Top View of Board)

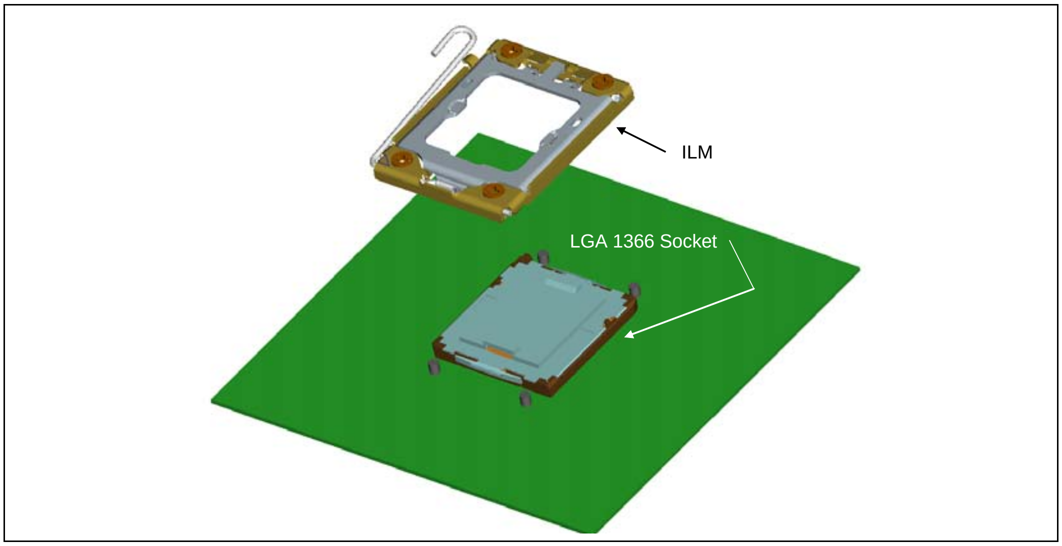


2.2 Attachment to Motherboard

The socket is attached to the motherboard by 1366 solder balls. There are no additional external methods (that is, screw, extra solder, adhesive, and so on) to attach the socket.

As indicated in Figure 2-4, the Independent Loading Mechanism (ILM) is not present during the attach (reflow) process.

Figure 2-4. Attachment to Motherboard



2.3 Socket Components

The socket has two main components, the socket body and Pick and Place (PnP) cover, and is delivered as a single integral assembly. Refer to Appendix C for detailed drawings.

2.3.1 Socket Body Housing

The housing material is thermoplastic or equivalent with UL 94 V-0 flame rating capable of withstanding 260 °C for 40 seconds (typical reflow/rework). The socket coefficient of thermal expansion (in the XY plane), and creep properties, must be such that the integrity of the socket is maintained for the conditions listed in the LGA1366 Socket Validation Reports.

The color of the housing will be dark as compared to the solder balls to provide the contrast needed for pick and place vision systems.

2.3.2 Solder Balls

A total of 1366 solder balls corresponding to the contacts are on the bottom of the socket for surface mounting with the motherboard.

The socket has the following solder ball material:

- Lead free SAC (SnAgCu) solder alloy with a silver (Ag) content between 3% and 4% and a melting temperature of approximately 217 °C. The alloy must be compatible with immersion silver (ImAg) motherboard surface finish and a SAC alloy solder paste.

The co-planarity (profile) and true position requirements are defined in Appendix C.

2.3.3 Contacts

Base material for the contacts is high strength copper alloy.

For the area on socket contacts where processor lands will mate, there is a 0.381 μm [15 μinches] minimum gold plating over 1.27 μm [50 μinches] minimum nickel underplate.

No contamination by solder in the contact area is allowed during solder reflow.

2.3.4 Pick and Place Cover

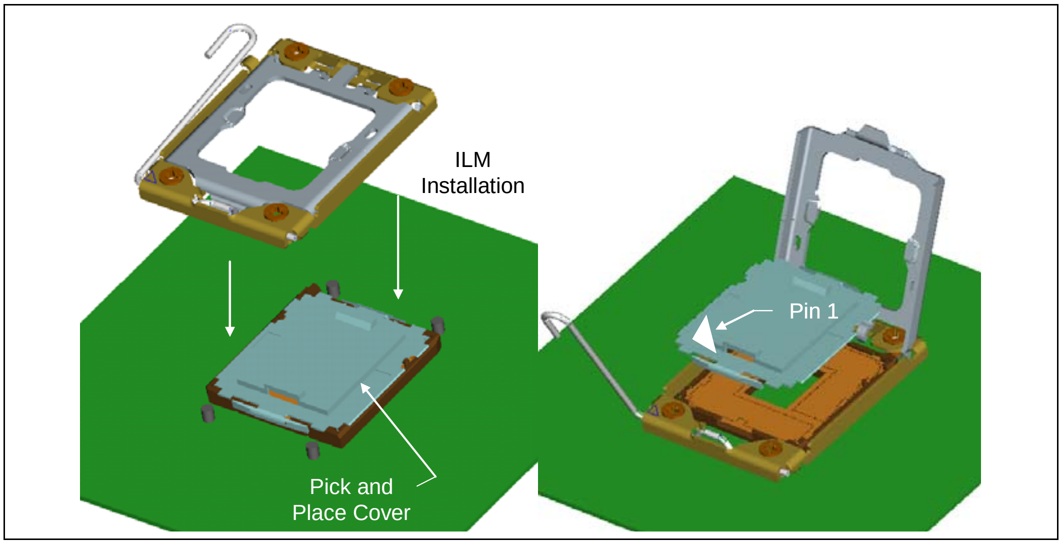
The cover provides a planar surface for vacuum pick up used to place components in the Surface Mount Technology (SMT) manufacturing line. The cover remains on the socket during reflow to help prevent contamination during reflow. The cover can withstand 260 °C for 40 seconds (typical reflow/rework profile) and the conditions listed in the LGA1366 Socket Validation Reports without degrading.

As indicated in Figure 2-5, the cover remains on the socket during ILM installation, and should remain on whenever possible to help prevent damage to the socket contacts.

Cover retention must be sufficient to support the socket weight during lifting, translation, and placement (board manufacturing), and during board and system shipping and handling.

The covers are designed to be interchangeable between socket suppliers. As indicated in Figure 2-5, a Pin1 indicator on the cover provides a visual reference for proper orientation with the socket.

Figure 2-5. Pick and Place Cover



2.4 Package Installation / Removal

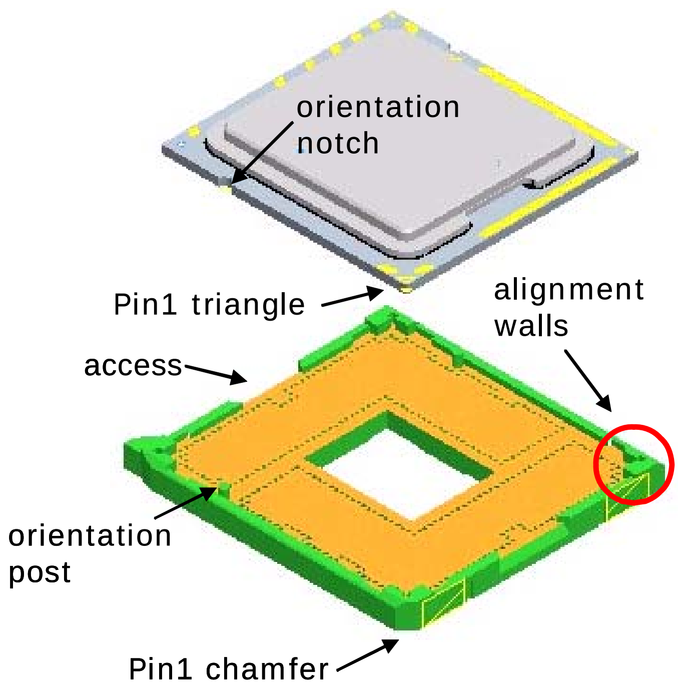
As indicated in Figure 2-6, access is provided to facilitate manual installation and removal of the package.

To assist in package orientation and alignment with the socket:

- The package Pin1 triangle and the socket Pin1 chamfer provide visual reference for proper orientation.
- The package substrate has orientation notches along two opposing edges of the package, offset from the centerline. The socket has two corresponding orientation posts to physically prevent mis-orientation of the package. These orientation features also provide initial rough alignment of package to socket.
- The socket has alignment walls at the four corners to provide final alignment of the package.

See Appendix F for information regarding a tool designed to provide mechanical assistance during processor installation and removal.

Figure 2-6. Package Installation / Removal Features



2.4.1 Socket Standoffs and Package Seating Plane

Standoffs on the bottom of the socket base establish the minimum socket height after solder reflow and are specified in Appendix C.

Similarly, a seating plane on the topside of the socket establishes the minimum package height. See Section 4.2 for the calculated IHS height above the motherboard.

2.5 Durability

The socket must withstand 30 cycles of processor insertion and removal. The max chain contact resistance from Table 4-4 must be met when mated in the 1st and 30th cycles.

The socket Pick and Place cover must withstand 15 cycles of insertion and removal.

2.6 Markings

There are three markings on the socket:

- LGA1366: Font type is Helvetica Bold - minimum 6 point (2.125 mm).
- Manufacturer's insignia (font size at supplier's discretion).
- Lot identification code (allows traceability of manufacturing date and location).

All markings must withstand 260 °C for 40 seconds (typical reflow/rework profile) without degrading, and must be visible after the socket is mounted on the motherboard.

LGA1366 and the manufacturer's insignia are molded or laser marked on the side wall.

2.7 Component Insertion Forces

Any actuation must meet or exceed SEMI S8-95 Safety Guidelines for Ergonomics/ Human Factors Engineering of Semiconductor Manufacturing Equipment, example Table R2-7 (Maximum Grip Forces). The socket must be designed so that it requires no force to insert the package into the socket.

2.8 Socket Size

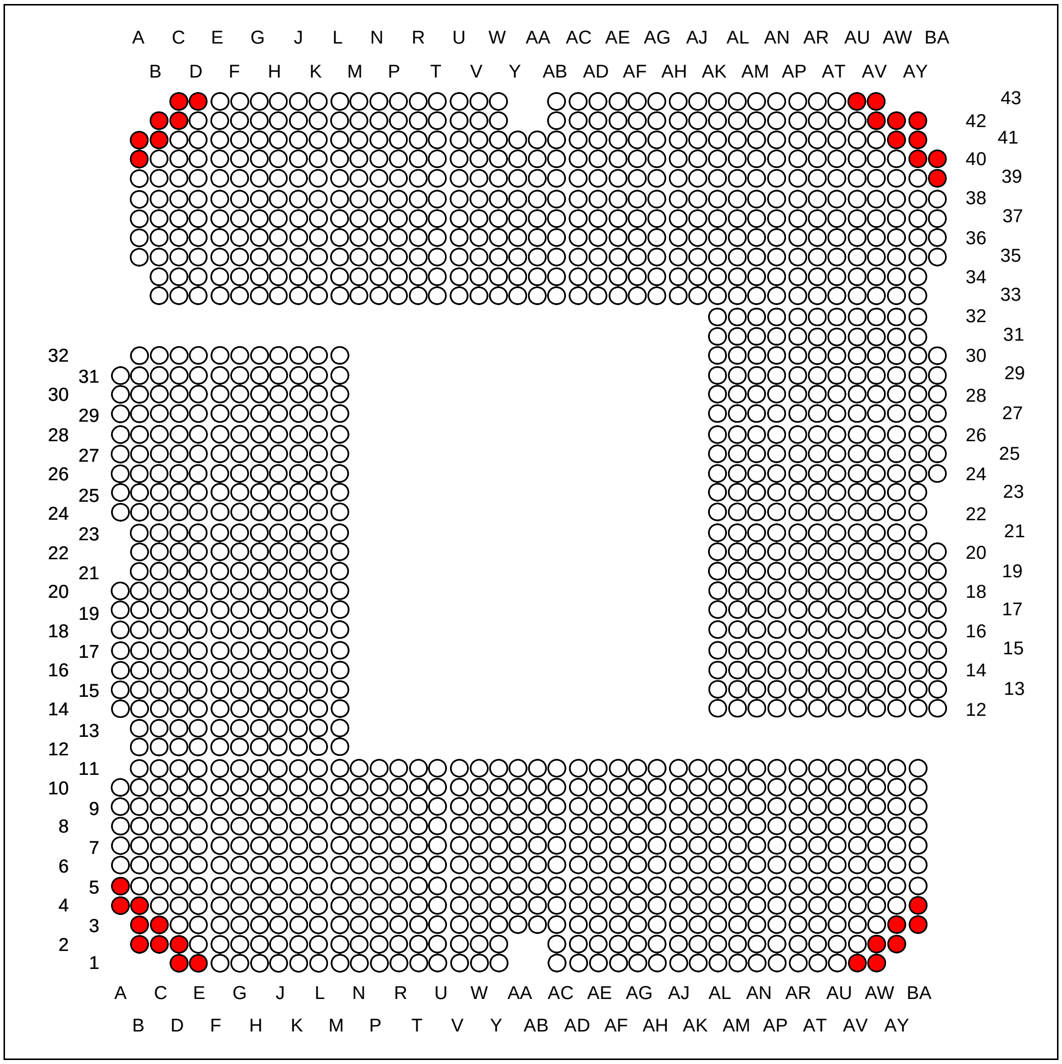
Socket information needed for motherboard design is given in Appendix C.

This information should be used in conjunction with the reference motherboard keep-out drawings provided in Appendix B to ensure compatibility with the reference thermal mechanical components.

2.9 LGA1366 Socket NCTF Solder Joints

Intel has defined selected solder joints of the socket as non-critical to function (NCTF) for post environmental testing. The processor signals at NCTF locations are typically redundant ground or non-critical reserved, so the loss of the solder joint continuity at end of life conditions will not affect the overall product functionality. Figure 2-7 identifies the NCTF solder joints.

Figure 2-7. LGA1366 NCTF Solder Joints



Note: For platforms supporting the DP processor land C3 is CTF.

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3 Independent Loading Mechanism (ILM)

The Independent Loading Mechanism (ILM) provides the force needed to seat the 1366-LGA land package onto the socket contacts. The ILM is physically separate from the socket body. The assembly of the ILM to the board is expected to occur after wave solder. The exact assembly location is dependent on manufacturing preference and test flow.

Note: The ILM has two critical functions: deliver the force to seat the processor onto the socket contacts and distribute the resulting compressive load evenly through the socket solder joints.

Note: The mechanical design of the ILM is integral to the overall functionality of the LGA1366 socket. Intel performs detailed studies on integration of processor package, socket and ILM as a system. These studies directly impact the design of the ILM. The Intel reference ILM will be “build to print” from Intel controlled drawings. Intel recommends using the Intel Reference ILM. Custom non-Intel ILM designs do not benefit from Intel's detailed studies and may not incorporate critical design parameters.

3.1 Design Concept

The ILM consists of two assemblies that will be procured as a set from the enabled vendors. These two components are ILM cover assembly and back plate.

3.1.1 ILM Cover Assembly Design Overview

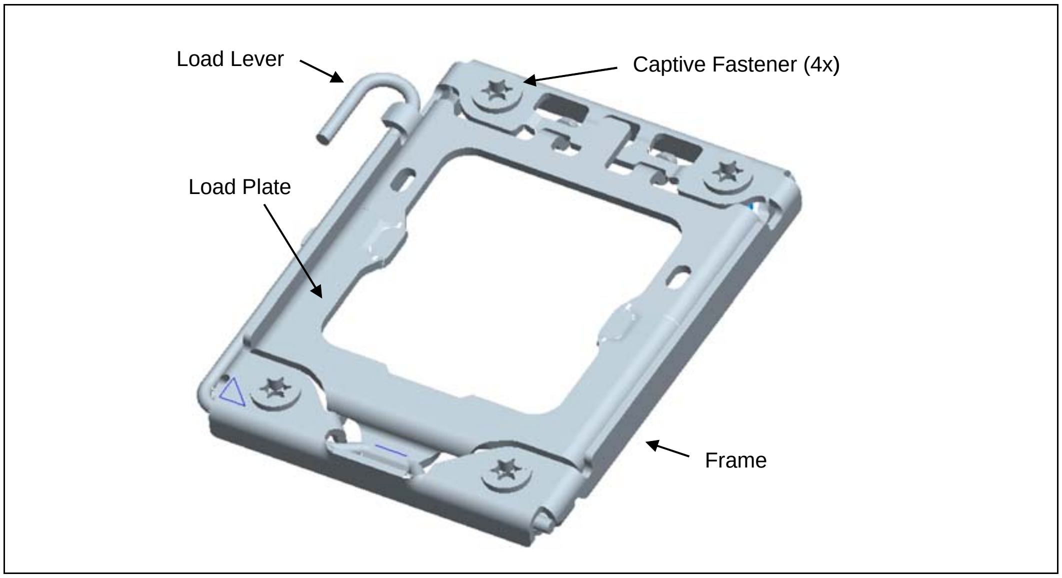
The ILM Cover assembly consists of four major pieces: load lever, load plate, frame and the captive fasteners.

The load lever and load plate are stainless steel. The frame and fasteners are high carbon steel with appropriate plating. The fasteners are fabricated from a high carbon steel. The frame provides the hinge locations for the load lever and load plate.

The cover assembly design ensures that once assembled to the back plate and the load lever is closed, the only features touching the board are the captive fasteners. The nominal gap of the frame to the board is ~1 mm when the load plate is closed on the empty socket or when closed on the processor package.

When closed, the load plate applies two point loads onto the IHS at the “dimpled” features shown in Figure 3-1. The reaction force from closing the load plate is transmitted to the frame and through the captive fasteners to the back plate. Some of the load is passed through the socket body to the board inducing a slight compression on the solder joints.

Figure 3-1. ILM Cover Assembly

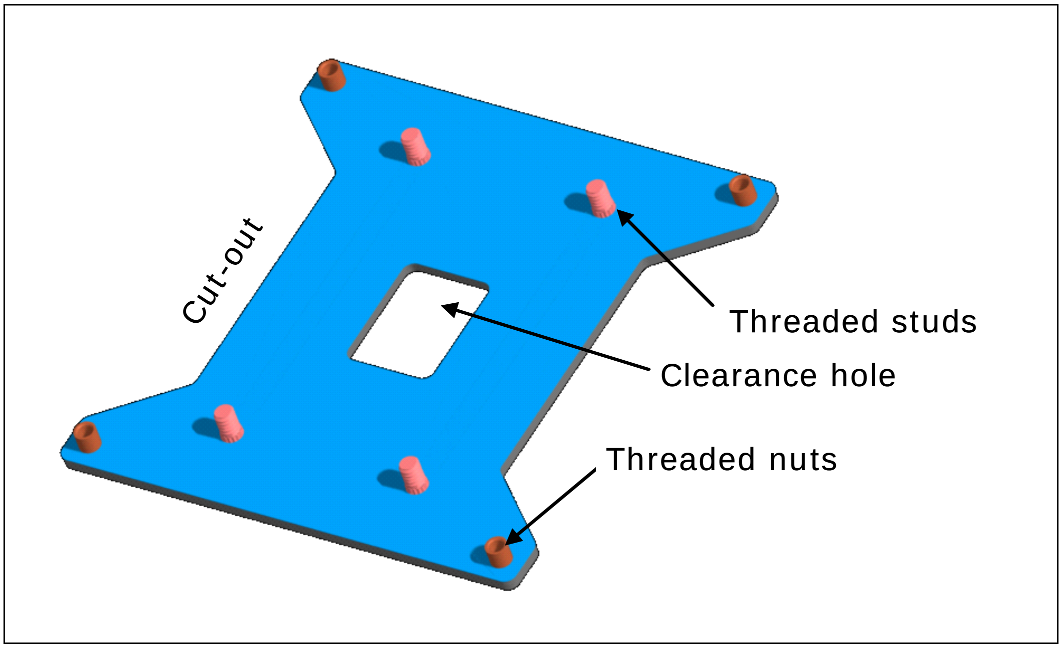


3.1.2 ILM Back Plate Design Overview

The unified back plate for 2-socket server and 2-socket Workstation products consists of a flat steel back plate with threaded studs for ILM attach, and internally threaded nuts for heatsink attach. The threaded studs have a smooth surface feature that provides alignment for the back plate to the motherboard for proper assembly of the ILM around the socket. A clearance hole is located at the center of the plate to allow access to test points and backside capacitors. An additional cut-out on two sides provides clearance for backside voltage regulator components. An insulator is pre-applied.

Back plates for processors in 1-socket Workstation platforms are covered in the *Intel® Xeon® Processor 3500 Series Thermal/Mechanical Design Guide*.

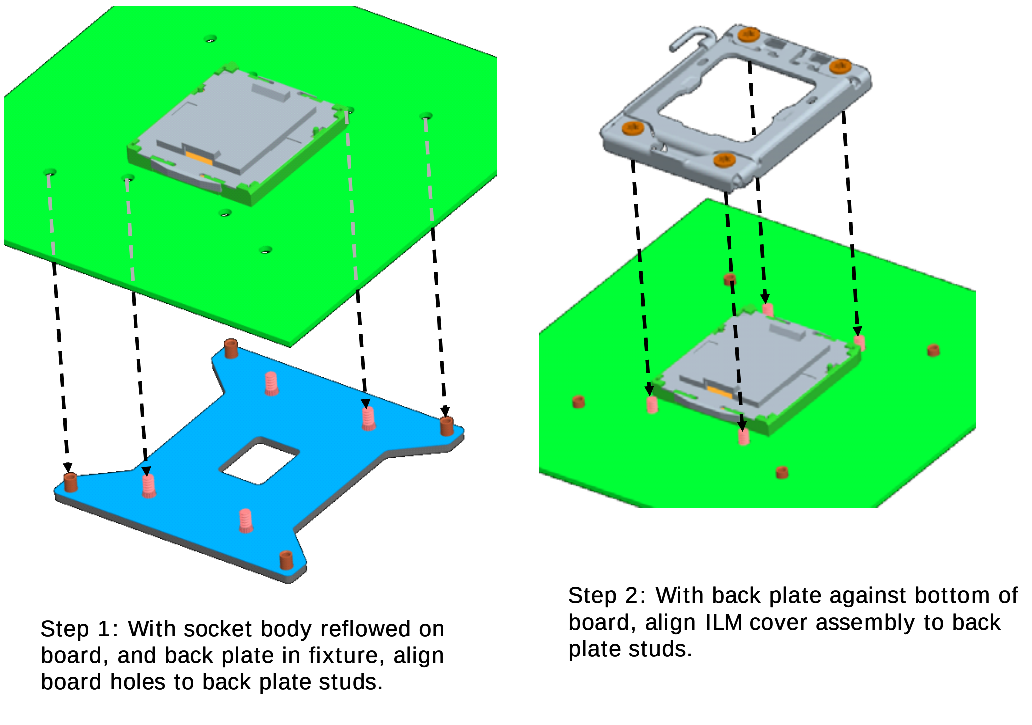
Figure 3-2. Back Plate



3.2 Assembly of ILM to a Motherboard

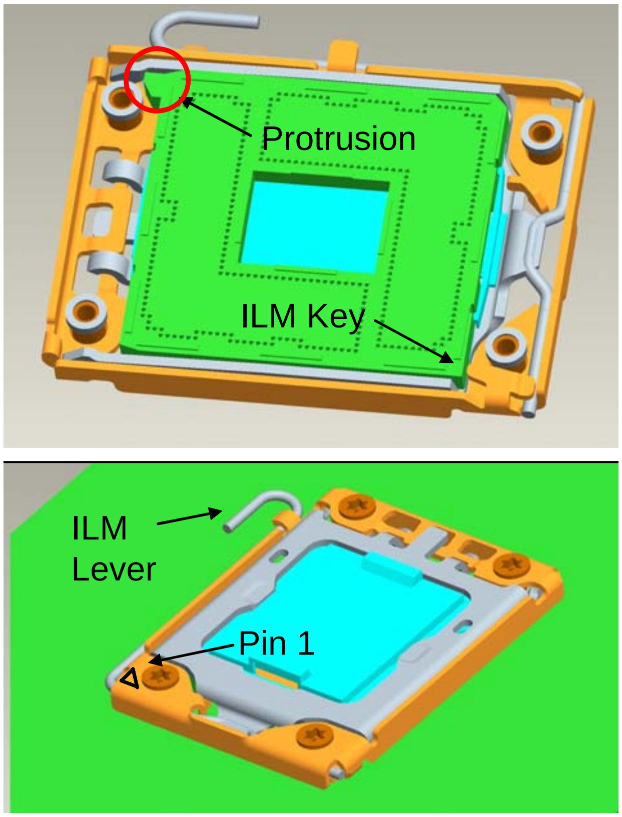
The ILM design allows a bottoms up assembly of the components to the board. In step 1, (see Figure 3-3), the back plate is placed in a fixture. Holes in the motherboard provide alignment to the threaded studs. In step 2, the ILM cover assembly is placed over the socket and threaded studs. Using a T20 Torx* driver fasten the ILM cover assembly to the back plate with the four captive fasteners. Torque to 8 ± 2 inch-pounds. The length of the threaded studs accommodate board thicknesses from 0.062” to 0.100”.

Figure 3-3. ILM Assembly



As indicated in Figure 3-4, socket protrusion and ILM key features prevent 180-degree rotation of ILM cover assembly with respect to the socket. The result is a specific Pin 1 orientation with respect to the ILM lever.

Figure 3-4. Pin1 and ILM Lever



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4 LGA1366 Socket and ILM Electrical, Mechanical, and Environmental Specifications

This chapter describes the electrical, mechanical, and environmental specifications for the LGA1366 socket and the Independent Loading Mechanism.

4.1 Component Mass

Table 4-1. Socket Component Mass

Component	Mass
Socket Body, Contacts and PnP Cover	15 gm
ILM Cover	43 gm
ILM Back Plate for dual processor server products	100 gm

4.2 Package/Socket Stackup Height

Table 4-2 provides the stackup height of a processor in the 1366-land LGA package and LGA1366 socket with the ILM closed and the processor fully seated in the socket.

Table 4-2. 1366-land Package and LGA1366 Socket Stackup Height

Integrated Stackup Height (mm) From Top of Board to Top of IHS	7.729 ± 0.282 mm

Notes:
1. This data is provided for information only, and should be derived from: (a) the height of the socket seating plane above the motherboard after reflow, given in Appendix C, (b) the height of the package, from the package seating plane to the top of the IHS, and accounting for its nominal variation and tolerances that are given in the corresponding processor EMTS.
2. This value is a RSS calculation.

4.3 Socket Maximum Temperature

The power dissipated within the socket is a function of the current at the pin level and the effective pin resistance. To ensure socket long term reliability, Intel defines socket maximum temperature using a via on the underside of the motherboard. Exceeding the temperature guidance may result in socket body deformation, or increases in thermal and electrical resistance which can cause a thermal runaway and eventual electrical failure. The guidance for socket maximum temperature is listed below:

- Via temperature under socket < 96 °C

4.4 Loading Specifications

The socket will be tested against the conditions listed in the LGA1366 Socket Validation Reports with heatsink and the ILM attached, under the loading conditions outlined in this chapter.

Table 4-3 provides load specifications for the LGA1366 socket with the ILM installed. The maximum limits should not be exceeded during heatsink assembly, shipping conditions, or standard use condition. Exceeding these limits during test may result in component failure. The socket body should not be used as a mechanical reference or load-bearing surface for thermal solutions.

Table 4-3. Socket and ILM Mechanical Specifications

Parameter	Min	Max	Notes
Static compressive load from ILM cover to processor IHS	470 N [106 lbf]	623 N [140 lbf]	3, 4
Heatsink Static Compressive Load	0 N [0 lbf]	266 N [60 lbf]	1, 2, 3
Total Static Compressive Load (ILM plus Heatsink)	470 N (106 lbf)	890 N (200 lbf)	3, 4
Dynamic Compressive Load (with heatsink installed)	N/A	890 N [200 lbf]	1, 3, 5, 6
Pick and Place Cover Insertion / Removal force	N/A	10.2 N [2.3 lbf]	
Load Lever actuation force	N/A	38.3 N [8.6 lbf] in the vertical direction 10.2 N [2.3 lbf] in the lateral direction.	

Notes:
1. These specifications apply to uniform compressive loading in a direction perpendicular to the IHS top surface.
2. This is the minimum and maximum static force that can be applied by the heatsink and it's retention solution to maintain the heatsink to IHS interface. This does not imply the Intel reference TIM is validated to these limits.
3. Loading limits are for the LGA1366 socket.
4. This minimum limit defines the compressive force required to electrically seat the processor onto the socket contacts.
5. Dynamic loading is defined as an 11 ms duration average load superimposed on the static load requirement.
6. Test condition used a heatsink mass of 550 gm [1.21 lb] with 50 g acceleration measured at heatsink mass. The dynamic portion of this specification in the product application can have flexibility in specific values, but the ultimate product of mass times acceleration should not exceed this dynamic load.

4.5 Electrical Requirements

LGA1366 socket electrical requirements are measured from the socket-seating plane of the processor to the component side of the socket PCB to which it is attached. All specifications are maximum values (unless otherwise stated) for a single socket contact, but includes effects of adjacent contacts where indicated.

Table 4-4. Electrical Requirements for LGA1366 Socket

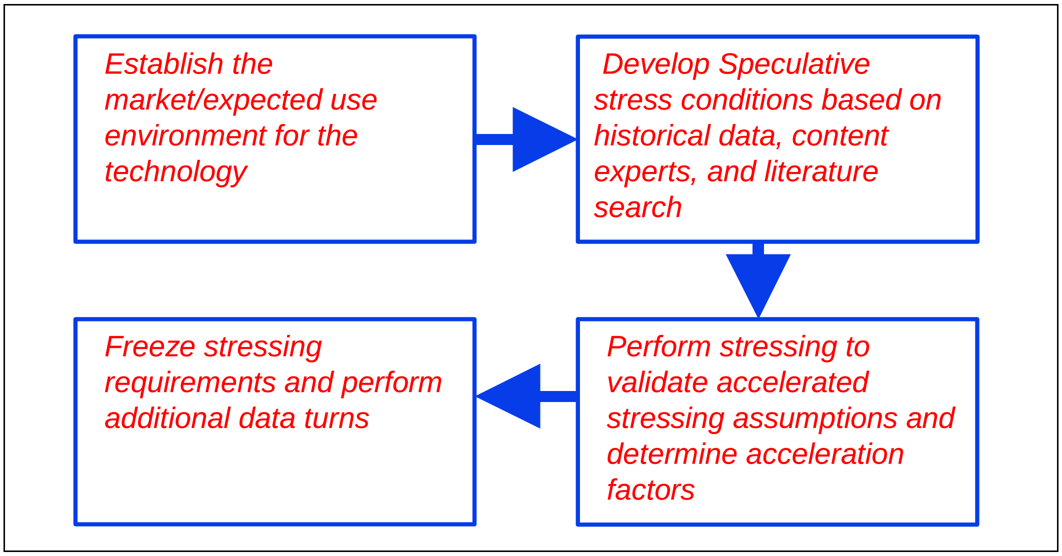
Parameter	Value	Comment
Mated loop inductance, Loop	<3.9nH	The inductance calculated for two contacts, considering one forward conductor and one return conductor. These values must be satisfied at the worst-case height of the socket.
Mated partial mutual inductance, L	NA	The inductance on a contact due to any single neighboring contact.
Maximum mutual capacitance, C.	<1 pF	The capacitance between two contacts
Socket Average Contact Resistance (EOL)	15.2 mΩ	The socket average contact resistance target is derived from average of every chain contact resistance for each part used in testing, with a chain contact resistance defined as the resistance of each chain minus resistance of shorting bars divided by number of lands in the daisy chain. The specification listed is at room temperature and has to be satisfied at all time. **Socket Contact Resistance:** The resistance of the socket contact, solderball, and interface resistance to the interposer land.
Max Individual Contact Resistance (EOL)	≤ 100 mΩ	The specification listed is at room temperature and has to be satisfied at all time. **Socket Contact Resistance:** The resistance of the socket contact, solderball, and interface resistance to the interposer land; gaps included.
Bulk Resistance Increase	≤ 3 mΩ	The bulk resistance increase per contact from 24 °C to 107 °C
Dielectric Withstand Voltage	360 Volts RMS	
Insulation Resistance	800 MΩ	

4.6 Environmental Requirements

Design, including materials, shall be consistent with the manufacture of units that meet the following environmental reference points.

The reliability targets in this chapter are based on the expected field use environment for these products. The test sequence for new sockets will be developed using the knowledge-based reliability evaluation methodology, which is acceleration factor dependent. A simplified process flow of this methodology can be seen in Figure 4-1.

Figure 4-1. Flow Chart of Knowledge-Based Reliability Evaluation Methodology



A detailed description of this methodology can be found at:

ftp://download.intel.com/technology/itj/q32000/pdf/reliability.pdf.

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5 Thermal Solutions

This section describes a 1U reference heatsink, design targets for 2U and Tower heatsinks, performance expectations for a 25.5 mm tall heatsink, and thermal design guidelines for Intel® Xeon® Processor 5500 Series and the follow-on processors.

5.1 Performance Targets

Table 5-1 provides boundary conditions and performance targets for 1U, 2U and Tower heatsinks. These values are used to generate processor thermal specifications and to provide guidance for heatsink design.

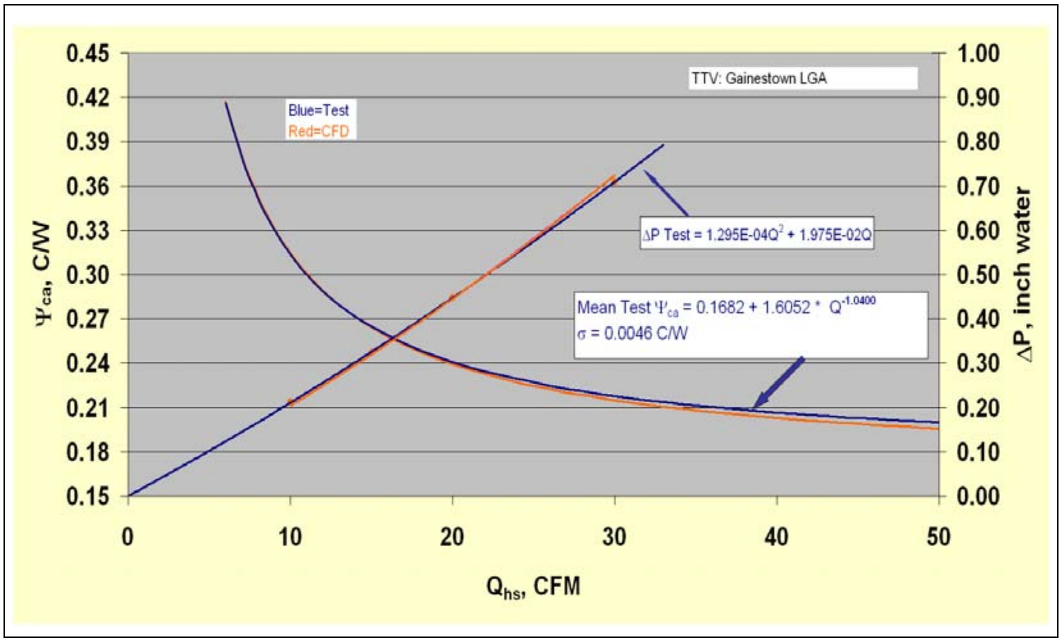
Table 5-1. Boundary Conditions and Performance Targets

Parameter	Value				
Altitude, system ambient temp	Sea level, 35°C				
TDP	60W	80W	95W, Profile B	95W, Profile A	130W, WS[9]
T_{LA}[1]	49°C	49°C	49°C	55°C	40°C
Ψ_{CA}[2]	0.335°C/W	0.336°C/W	0.337°C/W	0.201°C/W	0.201°C/W
Airflow[3]	9.7 CFM @ 0.20" dP	9.7 CFM @ 0.20" dP	9.7 CFM @ 0.20" dP	30 CFM @ 0.205" dP	30 CFM @ 0.205" dP
System height (form factor)[4]	1U (EEB)	1U (EEB)	1U (EEB)[5]	2U (EEB)	Pedestal (EEB)
Heatsink volumetric	90 x 90 x 27mm (1U)[6]			90 x 90 x 64mm (2U)[6,7]	90 x 90 x 99mm (Tower)[6]
Heatsink technology[8]	Cu base, Al fins			Cu/Al base, Al fins with heatpipes	

Notes:
1. Local ambient temperature of the air entering the heatsink.
2. Max target (mean + 3 sigma + offset) for thermal characterization parameter (Section 5.5.1).
3. Airflow through the heatsink fins with zero bypass. Max target for pressure drop (dP) measured in inches H_2O.
4. Reference system configuration. Processor is downstream from memory in EEB (Entry-Level Electronics Bay). Ducting is utilized to direct airflow.
5. The 1U heatsink can also meet Profile B for the 95W processor in TEB (Thin Electronics Bay) under the following conditions: TLA = 40°C, ΨCA = 0.275°C/W, airflow = 16 CFM @ 0.344" dP (these TEB values are not used to generate processor thermal specifications). Processor is not downstream from memory in TEB. Ducting is utilized to direct airflow.
6. Dimensions of heatsink do not include socket or processor.
7. The 2U heatsink height (64mm) + socket/processor height (7.729 mm, Table 4-2) complies with 76.2 mm max height for EEB monoplanar boards (http://ssiforum.oaktree.com/).
8. Passive heatsinks. PCM45F thermal interface material.
9. WS = Workstation.

For 1U reference heatsink, see Appendix B for detailed drawings. Table 5-1 specifies Ψ_{CA} and pressure drop targets at 9.7 CFM. Figure 5-1 shows Ψ_{CA} and pressure drop for the 1U heatsink versus the airflow provided. Best-fit equations are provided to prevent errors associated with reading the graph.

Figure 5-1. 1U Heatsink Performance Curves



For 2U and Tower heatsink, see Appendix B for volumetric drawings. Table 5-1 specifies Ψ_{CA} and pressure drop targets at 30 CFM. At airflows other than 30 CFM, Ψ_{CA} and pressure drop will differ between suppliers as their heatpipe and fin geometries will vary.

5.1.1 25.5 mm Tall Heatsink

For the 25.5 mm tall heatsink, Table 5-2 provides guidance regarding performance expectations. These values are not used to generate processor thermal specifications.

Table 5-2. Performance Expectations for 25.5 mm Tall Heatsink

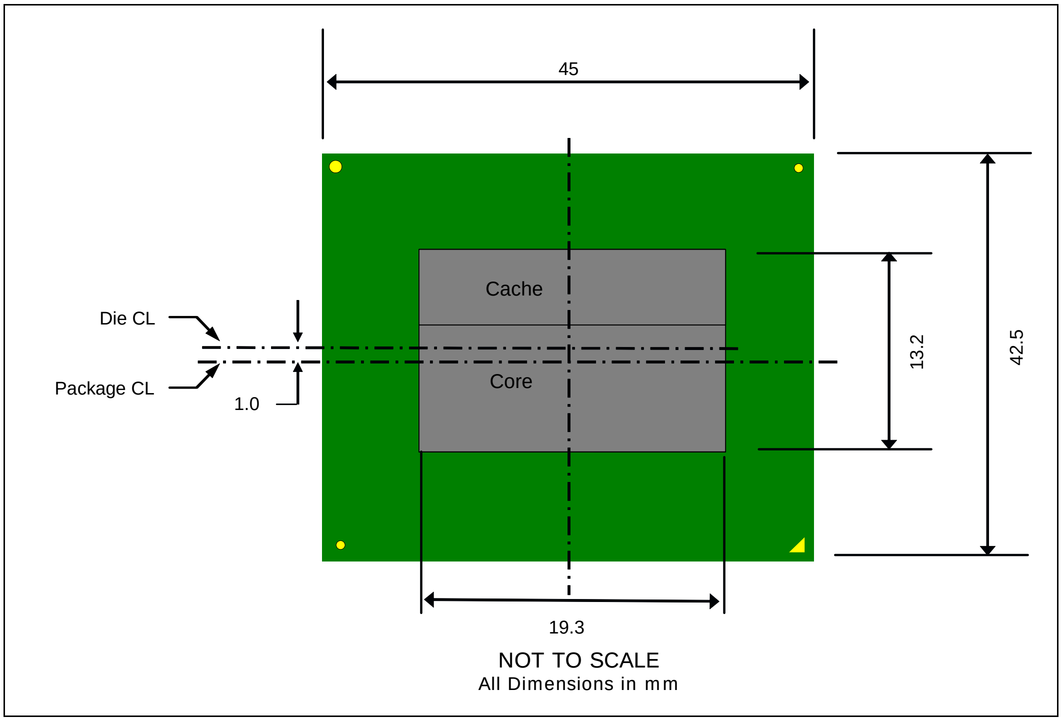
Parameter	Value		
Altitude, system ambient temp	Sea level, 35°C		
TDP	95W, Profile B		
T_{LA}[1]	50°C	49°C	40°C
Ψ_{CA}[2]	0.287°C/W	0.337°C/W	0.275°C/W
Airflow[3]	13.3 CFM @ 0.334" dP	10 CFM @ 0.210" dP	16 CFM @ 0.354" dP
System height (form factor)[4]	SSI blade	1U (EEB)	1U (TEB)
Heatsink volumetric	90 x 90 x 25.5mm (1U)[5]		
Heatsink technology[6]	Cu base, Al fins		

Notes:
1. Local ambient temperature of the air entering the heatsink.
2. Max target (mean + 3 sigma + offset) for thermal characterization parameter (Section 5.5.1).
3. Airflow through the heatsink fins with zero bypass. Max target for pressure drop (dP) measured in inches H_2O.
4. Reference system configuration. Processor is downstream from memory in SSI blade and EEB (Entry-Level Electronics Bay), not in TEB (Thin Electronics Bay). Ducting is utilized to direct airflow.
5. Dimensions of heatsink do not include socket or processor. The 25.5 mm heatsink height + socket/processor height (7.729 mm, Table 4-2) complies with 33.5mm max height for SSI blade boards (http://ssiforum.oaktree.com/).
6. Passive heatsinks. Dow Corning TC-1996 thermal interface material.

5.2 Heat Pipe Considerations

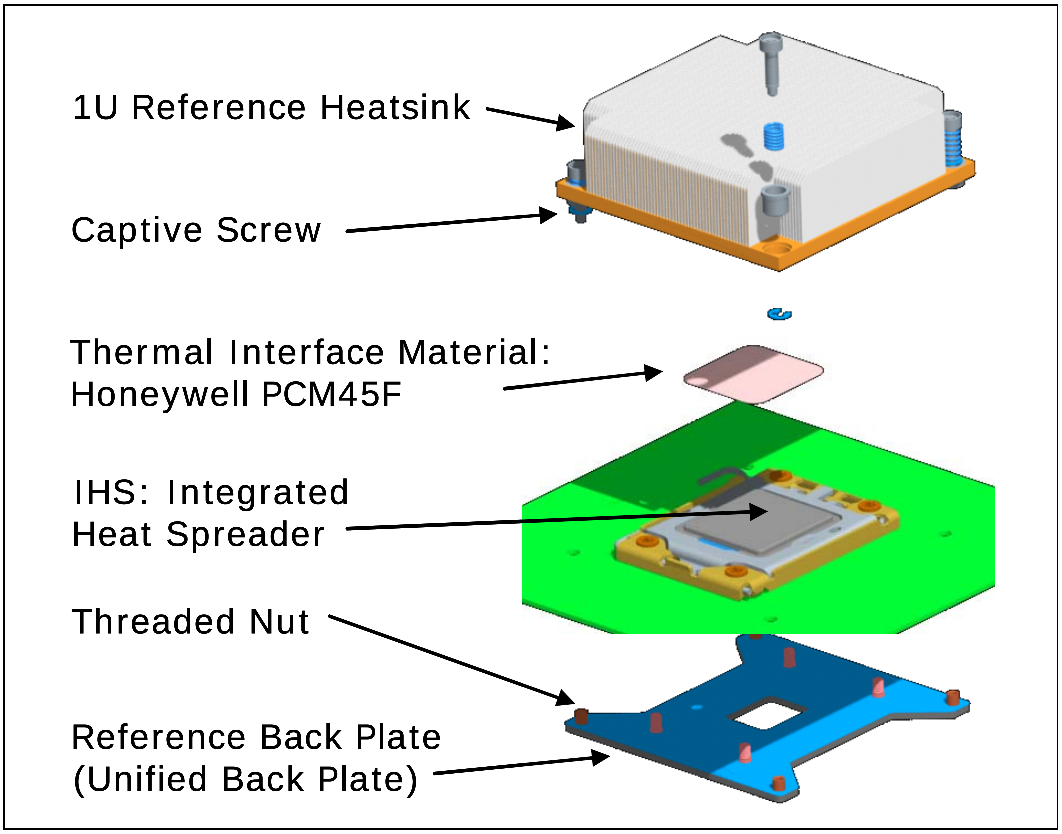
Figure 5-2 shows the orientation and position of the TTV die. The TTV die is sized and positioned similarly to the processor die.

Figure 5-2. TTV Die Size and Orientation



5.3 Assembly

Figure 5-3. 1U Reference Heatsink Assembly



The assembly process for the 1U reference heatsink begins with application of Honeywell PCM45F thermal interface material to improve conduction from the IHS. Tape and roll format is recommended. Pad size is 35 x 35mm, thickness is 0.25mm.

Next, position the heatsink such that the heatsink fins are parallel to system airflow. While lowering the heatsink onto the IHS, align the four captive screws of the heatsink to the four threaded nuts of the back plate.

Using a #2 Phillips driver, torque the four captive screws to 8 inch-pounds.

This assembly process is designed to produce a static load of 39 - 51 lbf, for 0.062" - 0.100" board thickness respectively. Honeywell PCM45F is expected to meet the performance targets in Table 5-1 from 30 - 60 lbf. From Table 4-3, the Heatsink Static Compressive Load of 0 - 60 lbf allows for designs that vary from the 1U reference heatsink. Example: A customer's unique heatsink with very little static load (as little as 0 lbf) is acceptable from a socket loading perspective as long as the T_{CASE} specification is met.

Compliance to Board Keepout Zones in Appendix B is assumed for this assembly process.

5.3.1 Thermal Interface Material (TIM)

TIM should be verified to be within its recommended shelf life before use.

Surfaces should be free of foreign materials prior to application of TIM.

Use isopropyl alcohol and a lint free cloth to remove old TIM before applying new TIM.

5.4 Structural Considerations

Mass of the 1U reference heatsink and the target mass for 2U and Tower heatsinks does not exceed 500 gm.

From Table 4-3, the Dynamic Compressive Load of 200 lbf max allows for designs that exceed 500 gm as long as the mathematical product does not exceed 200 lbf. Example: A heatsink of 2-lb mass (908 gm) x 50 g (acceleration) x 2.0 Dynamic Amplification Factor = 200 lbf. The Total Static Compressive Load (Table 4-3) should also be considered in dynamic assessments.

The heatsink limit of 500 gm and use of back plate have eliminated the need for Direct Chassis Attach retention (as used previously with the Intel® Xeon® processor 5000 sequence). Direct contact between back plate and chassis pan will help minimize board deflection during shock.

Placement of board-to-chassis mounting holes also impacts board deflection and resultant socket solder ball stress. Customers need to assess shock for their designs as their heatsink retention (back plate), heatsink mass and chassis mounting holes may vary.

5.5 Thermal Design

5.5.1 Thermal Characterization Parameter

The case-to-local ambient Thermal Characterization Parameter (Ψ_{CA}) is defined by:

Equation 5-1. $\Psi_{CA} = (T_{CASE} - T_{LA}) / TDP$

Where:

T_{CASE}	=	Processor case temperature (°C). For T_{CASE} specification see the appropriate Datasheet.
T_{LA}	=	Local ambient temperature in chassis at processor (°C).
TDP	=	TDP (W) assumes all power dissipates through the integrated heat spreader. This inexact assumption is convenient for heatsink design. TTVs are often used to dissipate TDP. Correction offsets account for differences in temperature distribution between processor and TTV.

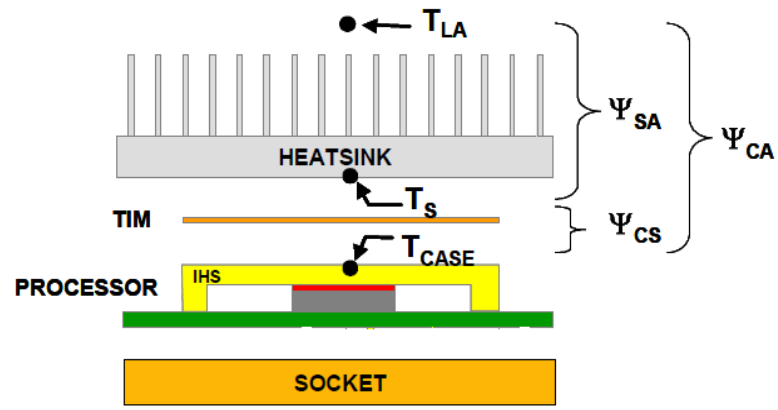
Equation 5-2. $\Psi_{CA} = \Psi_{CS} + \Psi_{SA}$

Where:

Ψ_{CS}	=	Thermal characterization parameter of the TIM (°C/W) is dependent on the thermal conductivity and thickness of the TIM.
Ψ_{SA}	=	Thermal characterization parameter from heatsink-to-local ambient (°C/W) is dependent on the thermal conductivity and geometry of the heatsink and dependent on the air velocity through the heatsink fins.

Figure 5-4 illustrates the thermal characterization parameters.

Figure 5-4. Processor Thermal Characterization Parameter Relationships

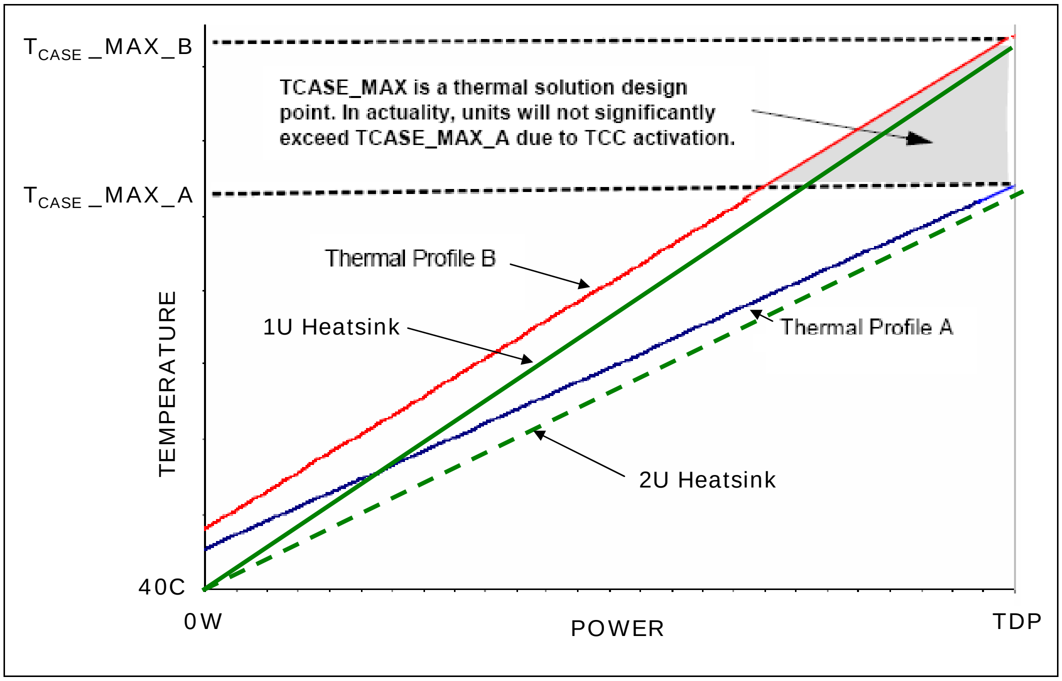


5.5.2 Dual Thermal Profile

Processors that offer dual thermal profile are specified in the appropriate Datasheet.

Dual thermal profile helps mitigate limitations in volumetrically constrained form factors and allows trade-offs between heatsink cost and TCC activation risk. For heatsinks that comply to Profile B, yet do not comply to Profile A (1U heatsink in Figure 5-5), the processor has an increased probability of TCC activation and an associated measurable performance loss. Measurable performance loss is defined to be any degradation in processor performance greater than 1.5%. 1.5% is chosen as the baseline since run-to-run variation in a performance benchmark is typically between 1 and 2%.

Figure 5-5. Dual Thermal Profile



Compliance to Profile A ensures that no measurable performance loss will occur due to TCC activation. It is expected that TCC would only be activated for very brief periods of time when running a worst-case real world application in a worst-case thermal condition. A worst-case real world application is a commercially available, useful application which dissipates power above TDP for a thermally relevant timeframe. One example of a worst-case thermal condition is when the processor local ambient temperature is above the y-axis intercept for Profile A.

5.6 Thermal Features

More information regarding processor thermal features is contained in the appropriate Datasheet.

5.6.1 Fan Speed Control

There are many ways to implement fan speed control. Using processor ambient temperature (in addition to Digital Thermal Sensor) to scale fan speed can improve acoustics when DTS > $T_{CONTROL}$.

Table 5-3. Fan Speed Control, $T_{CONTROL}$ and DTS Relationship

Condition	FSC Scheme
DTS ≤ $T_{CONTROL}$	FSC can adjust fan speed to maintain DTS ≤ $T_{CONTROL}$ (low acoustic region).
DTS > $T_{CONTROL}$	FSC should adjust fan speed to keep T_{CASE} at or below the Thermal Profile specification (increased acoustic region).

5.6.1.1 $T_{CONTROL}$ Guidance

Factory configured $T_{CONTROL}$ values are available in the appropriate Dear Customer Letter or may be extracted by issuing a Mailbox or an RDMSR instruction. See the *Intel® Xeon® Processor 5500 Series Datasheet, Volume 1* for more information.

Due to increased thermal headroom based on thermal characterization on the latest stepping of Intel® Xeon® Processor 5500 Series production processors, customers have the option to reduce $T_{CONTROL}$ to values lower than the factory configured values.

In some situations, use of reduced $T_{CONTROL}$ Guidance can reduce average fan power and improve acoustics. Implementation is optional. Alternately, the factory configured $T_{CONTROL}$ values can still be used. There are no plans to change Intel's specification or the factory configured $T_{CONTROL}$ values on individual processors.

To implement this guidance, customers must re-write code to set $T_{CONTROL}$ to the reduced values provided in the table below.

Table 5-4. $T_{CONTROL}$ Guidance

TDP	$T_{CONTROL}$ Guidance	Comment
95W	-10	Intel® Xeon® Processor 5500 Series with 2.93 GHz Max Core Frequency
95W	-1	Intel® Xeon® Processor 5500 Series frequencies lower than 2.93 GHz
80W	-1	Intel® Xeon® Processor 5500 Series 2.53 GHz or lower, except Embedded (NEBS)
60W	-1	Intel® Xeon® Processor 5500 Series 2.26 GHz or lower, except Embedded (NEBS)

Implementation of $T_{CONTROL}$ Guidance above maintains Intel standards of reliability (based on modeling of the Intel Reference Design). Implementation of $T_{CONTROL}$ of -1 may increase risk of throttling (Thermal Control Circuit activation). Increased TCC activation may or may not result in measurable performance loss.

Thermal Profile still applies. If PECI >= $T_{CONTROL}$ Guidance, then the case temperature must meet the Thermal Profile.

$T_{CONTROL}$ values for the follow-on processor are TBD but expected to be in the range of the factory configured $T_{CONTROL}$ values for Intel® Xeon® Processor 5500 Series. Regardless of $T_{CONTROL}$ values used in Intel® Xeon® Processor 5500 Series, BIOS needs to identify the processor type. For the follow-on processor, the fan speed control algorithm needs to use the follow-on processor's factory configured $T_{CONTROL}$ values.

5.6.2 PECI Averaging and Catastrophic Thermal Management

By averaging DTS over PECI, thermal solution failure can be detected and a soft shutdown can be initiated to help prevent loss of data.

Thermal data is averaged over a rolling window of 256mS by default (X=8):

$$AVG_N = AVG_{N-1} * (1 - 1/2^X) + Temperature * 1/2^X$$

Using a smaller averaging constant could cause premature detection of failure.

The Critical Temperature threshold generally triggers somewhere between PECI of -0.75 and -0.50. To avoid false shutdowns, initiate soft shutdown at -0.25.

Since customer designs, boundary conditions, and failure scenarios differ, above guidance should be tested in the customer's system to prevent loss of data during shutdown.

5.6.3 Intel® Turbo Boost Technology

Intel® Turbo Boost Technology (Intel® TBT) is a new feature available on certain processor SKUs that opportunistically, and automatically, allows the processor to run faster than the marked frequency if the part is operating below its power, temperature and current limits.

Heatsink performance (lower Ψ_{CA} as described in Section 5.5.1) is one of several factors that can impact the amount of Intel® TBT frequency benefit. Intel® TBT performance is also constrained by ICC, and VCC limits.

Increased IMON accuracy may provide more Intel® TBT benefit on TDP limited applications, as compared to lower Ψ_{CA}, as temperature is not typically the limiter for these workloads.

With Intel® TBT enabled, the processor may run more consistently at higher power levels (but still within TDP), and be more likely to operate above $T_{CONTROL}$, as compared to when Intel® TBT is disabled. This may result in higher acoustics.

With Intel® TBT enabled, processors with dual thermal profiles (described in Section 5.5.2, have greater potential for performance delta between Profile A and Profile B platforms, as compared to previous platforms.

5.7 Thermal Guidance

5.7.1 Thermal Excursion Power for 95 W Processor

Under fan failure or other anomalous thermal excursions, Tcase may exceed Thermal Profile B for a duration totaling less than 360 hours per year without affecting long term reliability (life) of the processor. For more typical thermal excursions, Thermal Monitor is expected to control the processor power level as long as conditions do not allow the Tcase to exceed the temperature at which Thermal Control Circuit (TCC) activation initially occurred. Under more severe anomalous thermal excursions when the processor temperature cannot be controlled at or below this Tcase level by TCC activation, then data integrity is not assured. At some higher threshold, THERMTRIP# will enable a shut down in an attempt to prevent permanent damage to the processor. Thermal Test Vehicle (TTV) may be used to check anomalous thermal excursion

compliance by ensuring that the processor Tcase value, as measured on the TTV, does not exceed Tcase_max_B at the anomalous power level for the environmental condition of interest. This anomalous power level is equal to 75% of the TDP limit.

5.7.2 Thermal Excursion Power for 80 W Processor

Under fan failure or other anomalous thermal excursions, Tcase may exceed the thermal profile for a duration totaling less than 360 hours per year without affecting long term reliability (life) of the processor. For more typical thermal excursions, Thermal Monitor is expected to control the processor power level as long as conditions do not allow the Tcase to exceed the temperature at which Thermal Control Circuit (TCC) activation initially occurred. Under more severe anomalous thermal excursions when the processor temperature cannot be controlled at or below this Tcase level by TCC activation, then data integrity is not assured. At some higher threshold, THERMTRIP# will enable a shut down in an attempt to prevent permanent damage to the processor. Thermal Test Vehicle (TTV) may be used to check anomalous thermal excursion compliance by ensuring that the processor Tcase value, as measured on the TTV, does not exceed Tcase_max at the anomalous power level for the environmental condition of interest. This anomalous power level is equal to 75% of the TDP limit.

5.7.3 Absolute Processor Temperature

Intel does not test any third party software that reports absolute processor temperature. As such, Intel cannot recommend the use of software that claims this capability. Since there is part-to-part variation in the TCC (thermal control circuit) activation temperature, use of software that reports absolute temperature can be misleading.

See the *Intel® Xeon® Processor 5500 Series Datasheet, Volume 1* for details regarding use of IA32_TEMPERATURE_TARGET register to determine the minimum absolute temperature at which the TCC will be activated and PROCHOT# will be asserted.

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6 Quality and Reliability Requirements

6.1 Test Conditions

The Test Conditions provided in Table 6-1 address processor heatsink failure mechanisms only. Test Conditions, Qualification and Visual Criteria vary by customer; Table 6-1 applies to Intel requirements.

Socket Test Conditions are provided in the LGA1366 Socket Validation Reports available from socket suppliers listed in Appendix A.

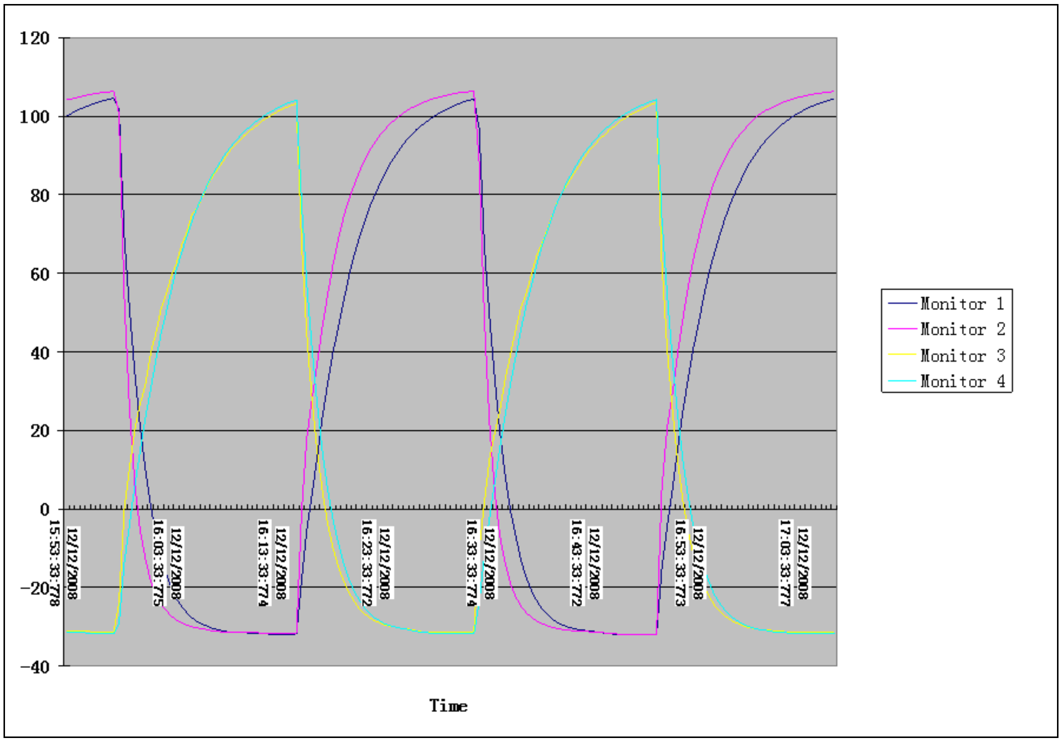
Table 6-1. Heatsink Test Conditions and Qualification Criteria (Sheet 1 of 2)

Assessment	Test Condition	Qualification Criteria	Min Sample Size
1) Humidity	Non-operating, 500 hours, +85°C and 85% R.H.	No visual defects. As verified in wind tunnel: • Mean Ψ_{CA} + 3s + offset not to exceed value in Table 5-1. • Pressure drop not to exceed value in Table 5-1.	15
2) Board-Level UnPackaged Shock	50G+/-10%; 170+/-10% in/sec; 3 drops per face, 6 faces.	No damage to heatsink base or pipe. No visual defects. As verified in wind tunnel: • Mean Ψ_{CA} + 2.54s + offset not to exceed value in Table 5-1. • Pressure drop not to exceed value in Table 5-1.	15
3) Board-Level UnPackaged Vibration	5 Hz @ 0.01 g2/Hz to 20 Hz @ 0.02 g2/Hz (slope up). 20 Hz to 500 Hz @ 0.02 g2/Hz (flat). Input acceleration is 3.13 g RMS. 10 minutes/axis for all 3 axes on all samples. Random control limit tolerance is ±3 dB.	No damage to heatsink base or pipe. No visual defects. As verified in wind tunnel: • Mean Ψ_{CA} + 2.54s + offset not to exceed value in Table 5-1 • Pressure drop not to exceed value in Table 5-1	15
4) First Article Inspection	Not Applicable	Meet all dimensions on 5 samples. Meet all CTF dimensions on 32 additional samples with 1.33 Cpk (mean + 4s). If samples are soft-tooled, a hard tool plan must be defined.	37
5) Shipping Media: Packaged Shock	Drop height determined by weight and may vary by customer; Intel requirement in General Supplier Packaging Spec. 10 drops (6 sides, 3 edges, 1 corner)	No visual defects	1 box
6) Shipping Media: Packaged Vibration	0.015 g2/Hz @ 10-40 Hz, sloping to 0.0015 g2/Hz @ 500 Hz, 1.03 gRMS, 1 hour/axis for 3 axes	No visual defects	1 box
7) Gravitational Evaluation	Required for heatpipe designs. 3 orientations (0°, +90°, -90°)	As verified in wind tunnel, mean Ψ_{CA} + 3s + offset not to exceed value in Table 5-1	15

Table 6-1. Heatsink Test Conditions and Qualification Criteria (Sheet 2 of 2)

Assessment	Test Condition	Qualification Criteria	Min Sample Size
8) Thermal Performance	Using 1U heatsink and 1U airflow from Table 5-1: 1) TTV @ 95W (Profile B), Note 1. Using 2U heatsink and 2U airflow from Table 5-1: 2) TTV @ 95W (Profile A), Note 1. 3) TTV @ 80W. 4) TTV @ 60W. Using Tower heatsink and Tower airflow from Table 5-1: 5) TTV @ 130W, Note 1. 6) TTV @ 95W (Profile A). 7) TTV @ 80W. 8) TTV @ 60W.	As verified in wind tunnel: 1) mean Ψ_{CA}+ 3s + offset not to exceed Table 5-1 value for 95W in 1U. 2-4) mean Ψ_{CA} + 3s + offset not to exceed Table 5-1 value for 2U. 5-8) mean Ψ_{CA} + 3s + offset not to exceed Table 5-1 value for Tower.	5 heatsinks X 8 tests by supplier. Note 1: 30 heatsinks X 3 tests by Intel.
9) Thermal Cycling	Required for heatpipe designs. Temperature range at pipe in heatsink assembly: -25C to +100C for 500 cycles. Cycle time is 30 minutes per full cycle, divided into half cycle in hot zone and half in cold zone, with minimum 1min soak at each temperature extreme for each cycle. See Figure 6-1 for example profile.	As verified in wind tunnel: • Mean Ψ_{CA} + 3s + offset not to exceed value in Table 5-1. • Pressure drop not to exceed value in Table 5-1.	15
10) Heat Pipe Burst	Continuously raise oven temperature and record the burst/leak temperatures of fully assembled heatsinks	No failures at minimum of 300C @ 20 minutes	32 pipes
11) Heatsink Mass	Design Target < 500 g	All samples < 550 g	30
12) Heatsink Load	Design Targets: 0.062" board = 38.7 ± 7.2 lbf (Fmin = 31.5 lbf). 0.100" board = 51.4 ± 7.9 lbf (Fmax = 59.3 lbf).	No samples < 30 lbf on 0.062" board. 5 highest load samples (from 0.062" test) < 60 lbf on 0.100" board	30

Figure 6-1. Example Thermal Cycle - Actual profile will vary



6.2 Intel Reference Component Validation

Intel tests reference components both individually and as an assembly on mechanical test boards, and assesses performance to the envelopes specified in previous sections by varying boundary conditions.

While component validation shows that a reference design is tenable for a limited range of conditions, customers need to assess their specific boundary conditions and perform reliability testing based on their use conditions.

Intel reference components are also used in board functional tests to assess performance for specific conditions.

6.2.1 Board Functional Test Sequence

Each test sequence should start with components (baseboard, heatsink assembly, and so on) that have not been previously submitted to any reliability testing.

The test sequence should always start with a visual inspection after assembly and BIOS/Processor/memory test. The stress test should be then followed by a visual inspection and then BIOS/Processor/memory test.

6.2.2 Post-Test Pass Criteria

The post-test pass criteria are:

1. No significant physical damage to the heatsink and retention hardware.

2. Heatsink remains seated and its bottom remains mated flat against the IHS surface. No visible gap between the heatsink base and processor IHS. No visible tilt of the heatsink with respect to the retention hardware.
3. No signs of physical damage on baseboard surface due to impact of heatsink.
4. No visible physical damage to the processor package.
5. Successful BIOS/Processor/memory test.
6. Thermal compliance testing to demonstrate that the case temperature specification can be met.

6.2.3 Recommended BIOS/Processor/Memory Test Procedures

This test is to ensure proper operation of the product before and after environmental stresses, with the thermal mechanical enabling components assembled. The test shall be conducted on a fully operational baseboard that has not been exposed to any battery of tests prior to the test being considered.

The testing setup should include the following components, properly assembled and/or connected:

- Appropriate system baseboard.
- Processor and memory.
- All enabling components, including socket and thermal solution parts.

The pass criterion is that the system under test shall successfully complete the checking of BIOS, basic processor functions and memory, without any errors.

6.3 Material and Recycling Requirements

Material shall be resistant to fungal growth. Examples of non-resistant materials include cellulose materials, animal and vegetable based adhesives, grease, oils, and many hydrocarbons. Synthetic materials such as PVC formulations, certain polyurethane compositions (for example, polyester and some polyethers), plastics which contain organic fillers of laminating materials, paints, and varnishes also are susceptible to fungal growth. If materials are not fungal growth resistant, then MIL-STD-810E, Method 508.4 must be performed to determine material performance.

Any plastic component exceeding 25 gm should be recyclable per the European Blue Angel recycling standards.

The following definitions apply to the use of the terms lead-free, Pb-free, and RoHS compliant.

Lead-free and Pb-free: Lead has not been intentionally added, but lead may still exist as an impurity below 1000 ppm.

RoHS compliant: Lead and other materials banned in RoHS Directive are either (1) below all applicable substance thresholds as proposed by the EU or (2) an approved/pending exemption applies.

Note: RoHS implementation details are not fully defined and may change.

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A Component Suppliers

Various suppliers have developed support components for processors in the Intel® Xeon® 5500 Platform. These suppliers and components are listed as a convenience to customers. Intel does not guarantee quality, reliability, functionality or compatibility of these components. The supplier list and/or the components may be subject to change without notice. Customers are responsible for the thermal, mechanical, and environmental verification of the components with the supplier.

A.1 Intel Enabled Supplier Information

Performance targets for heatsinks are described in Section 5.1. Mechanical drawings are provided in Appendix B. Mechanical models are listed in Table 1-1. Heatsinks assemble to server back plate Table A-4.

A.1.1 Intel Reference Thermal Solution

The Intel reference thermal solutions has been verified to meet the criteria outlined in Table 6-1. Customers can purchase the Intel reference thermal solutions from the suppliers listed in Table A-1.

Table A-1. Suppliers for the Intel Reference Thermal Solution

Assembly	Component	Description	Supplier PN	Supplier Contact Info
Assembly, Heat Sink, 1U	**1U URS Intel Reference Heatsink** p/n E32409-001	27 mm 1U Aluminum Fin, Copper Base, includes TIM, 95W capable	Fujikura HSA-8078 Rev A	Fujikura America Yuji Yasuda yuji@fujikura.com 408-748-6991
	1U URS SSI Blade Reference Heatsink p/n E39069-001 refers to E22056 Rev 02 + Snap Cover	25.5mm 1U Aluminum Fin, Copper Base, includes TIM and Snap Cover, 95W capable.	Fujikura HSA-8083C	Fujikura Taiwan Branch Yao-Hsien Huang yeohsien@fujikuratw.com.tw 886(2)8788-4959

A.1.2 Intel Collaboration Thermal Solution

The Intel collaboration thermal solutions are preliminary and may not be verified to meet the criteria outlined in Table 6-1. Customers can purchase the Intel collaboration thermal solutions from the suppliers listed in Table A-2.

Table A-2. Suppliers for the Intel Collaboration Thermal Solution

Assembly	Component	Description	Supplier PN	Supplier Contact Info
Assembly, Heatsink, Intel® Xeon® Processor 5500 Series, 2U	**2U URS Heatsink** Intel Collaboration Heatsink p/n E32410-001	Supplier Designed Solution with Intel-specified retention, includes TIM, 95W capable	Foxconn pn 1A016500	Foxconn Wanchi Chen (worldwide) wanchi.chen@foxconn.com (408) 919-6135
Assembly, Heatsink, Intel® Xeon® Processor 5500 Series, Pedestal	**Tower URS Heatsink** Intel Collaboration Heatsink p/n E32412-001	Supplier Designed Solution with Intel-specified retention, includes TIM, 130W capable	Chaun-Choung Technology Corp (CCI) pn 0007029401	Chaun-Choung Technology Corp (CCI) Monica Chih monica_chih@ccic.com.tw +886 (2) 2995-2666 x1131 Harry Lin hlinack@aol.com 714 739-5797

A.1.3 Alternative Thermal Solution

The alternative thermal solutions are preliminary and are not verified by Intel to meet the criteria outlined in Table 6-1. Customers can purchase the alternative thermal solutions from the suppliers listed in Table A-3.

Table A-3. Suppliers for the Alternative Thermal Solution

Assembly	Component	Description	Supplier PN	Supplier Contact Info
Assembly, Heat Sink, 1U	**1U SSI Blade Alternative URS Heatsink**	Supplier Designed Solution, Cu base, Al fins, 95W capable	TaiSol Corporation 1A1-9031000960-A	TaiSol Corporation Janice Chiu janice.chiu@taisol.com.tw +866-2-2656-2658
		Supplier Designed Solution, Cu base, Al fins, includes TIM, 95W capable	Thermaltake CL-P0484	Thermaltake Sean Li sean@thermaltake.com.tw +886-2-26626501 EXT.235
Assembly Heatsink, Intel® Xeon® Processor 5500 Series, 1U	**1U Alternative URS Heatsink**	Supplier Designed Solution, Cu base, Al fins, includes TIM, 95W capable	CoolerMaster S1N-PJFCS-07-GP	CoolerMaster Isaac Chu isaac_chu@coolermaster.com.tw +886 2 32340050 x11182
		Supplier Designed Solution, Cu base, Al fins, includes TIM, 95W capable	Aavid Thermalloy 050073	Aavid Thermalloy Chris Chapman chapman@aavid.com 603-223-1728 George Lee george.lee@aavid.com.tw +886 (2) 2698-9888 x603

Table A-3. Suppliers for the Alternative Thermal Solution

Assembly	Component	Description	Supplier PN	Supplier Contact Info
Assembly, Heatsink, Intel® Xeon® Processor 5500 Series, 2U	**2U Alternative URS Heatsink**	Supplier Designed Solution, Aluminum base, Cu insert, Al fins, heatpipes, includes TIM, 95W capable	Asia Vital Components (AVC) SR40400001	Asia Vital Components (AVC) David Chao david_chao@avc.com.tw +886 (2) 2299-6930 x7619
		Supplier Designed Solution, Cu base, Al fins, heatpipes, includes TIM, 95W capable	Thermaltake CL-P0486	Thermaltake Sean Li sean@thermaltake.com.tw +886-2-26626501 EXT.235
		Supplier Designed Solution, Cu base, Al fins, heatpipes, includes TIM, 95W capable	CoolerMaster S2N-PJMHS-07-GP	CoolerMaster Isaac Chu isaac_chu@coolermaster.com.tw +886 2 32340050 x11182
		Supplier Designed Solution, Cu base, Al fins, heatpipes, includes TIM, 95W capable	TaiSol Corporation 1A0-9041000960-A	TaiSol Corporation Janice Chiu janice.chiu@taisol.com.tw +886-2-2656-3658
		Supplier Designed Solution, Aluminum Extrusion, includes TIM, 80W capable	Dynatron Corporation G520	Dynatron Corporation Ian Lee ian@dynatron-corp.com 510-498-8888 x137
Assembly, Heatsink, Intel® Xeon® Processor 5500 Series, Tower	**Tower Alternative URS Heatsink**	Supplier Designed Solution, Al fins, heatpipes, 130W capable	TaiSol Corporation 1A0-9051000960-A	TaiSol Corporation Janice Chiu janice.chiu@taisol.com.tw +886-2-2656-3658
		Supplier Designed Solution, Al fins, heatpipes, 130W capable	Thermaltake CL-P0485	Thermaltake Sean Li sean@thermaltake.com.tw +886-2-26626501 EXT.235

A.1.4 Socket and ILM Components

The LGA1366 Socket and ILM Components are described in Chapter 2 and Chapter 3, respectively. Socket mechanical drawings are provided in Appendix C. Mechanical models are listed in Table 1-1.

Table A-4. LGA1366 Socket and ILM Components

Item	Intel PN	Foxconn	Tyco
ILM Cover Assembly	D92428-002	PT44L12-4101	1939738-1
Server Back Plate	D92433-002	PT44P12-4101	1981467-1
LGA1366 Socket	D86205-002	PE136627-4371-01F	1939737-1
Supplier Contact Info		Julia Jiang juliaj@foxconn.com 408-919-6178	Billy Hsieh billy.hsieh@tycoelectronics.com +81 44 844 8292

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B Mechanical Drawings

Table B-1. Mechanical Drawing List

Description	Figure
Board Keepin / Keepout Zones (Sheet 1 of 4)	Figure B-1
Board Keepin / Keepout Zones (Sheet 2 of 4)	Figure B-2
Board Keepin / Keepout Zones (Sheet 3 of 4)	Figure B-3
Board Keepin / Keepout Zones (Sheet 4 of 4)	Figure B-4
1U Reference Heatsink Assembly (Sheet 1 of 2)	Figure B-5
1U Reference Heatsink Assembly (Sheet 2 of 2)	Figure B-6
1U Reference Heatsink Fin and Base (Sheet 1 of 2)	Figure B-7
1U Reference Heatsink Fin and Base (Sheet 2 of 2)	Figure B-8
Heatsink Shoulder Screw (1U, 2U and Tower)	Figure B-9
Heatsink Compression Spring (1U, 2U and Tower)	Figure B-10
Heatsink Retaining Ring (1U, 2U and Tower)	Figure B-11
Heatsink Load Cup (1U, 2U and Tower)	Figure B-12
2U Collaborative Heatsink Assembly (Sheet 1 of 2)	Figure B-13
2U Collaborative Heatsink Assembly (Sheet 2 of 2)	Figure B-14
2U Collaborative Heatsink Volumetric (Sheet 1 of 2)	Figure B-15
2U Collaborative Heatsink Volumetric (Sheet 2 of 2)	Figure B-16
Tower Collaborative Heatsink Assembly (Sheet 1 of 2)	Figure B-17
Tower Collaborative Heatsink Assembly (Sheet 2 of 2)	Figure B-18
Tower Collaborative Heatsink Volumetric (Sheet 1 of 2)	Figure B-19
Tower Collaborative Heatsink Volumetric (Sheet 2 of 2)	Figure B-20
1U Reference Heatsink Assembly with TIM (Sheet 1 of 2)	Figure B-21
1U Reference Heatsink Assembly with TIM (Sheet 2 of 2)	Figure B-22
2U Reference Heatsink Assembly with TIM (Sheet 1 of 2)	Figure B-23
2U Reference Heatsink Assembly with TIM (Sheet 2 of 2)	Figure B-24
Tower Reference Heatsink Assembly with TIM (Sheet 1 of 2)	Figure B-25
Tower Reference Heatsink Assembly with TIM (Sheet 2 of 2)	Figure B-26

Figure B-1. Board Keepin / Keepout Zones (Sheet 1 of 4)

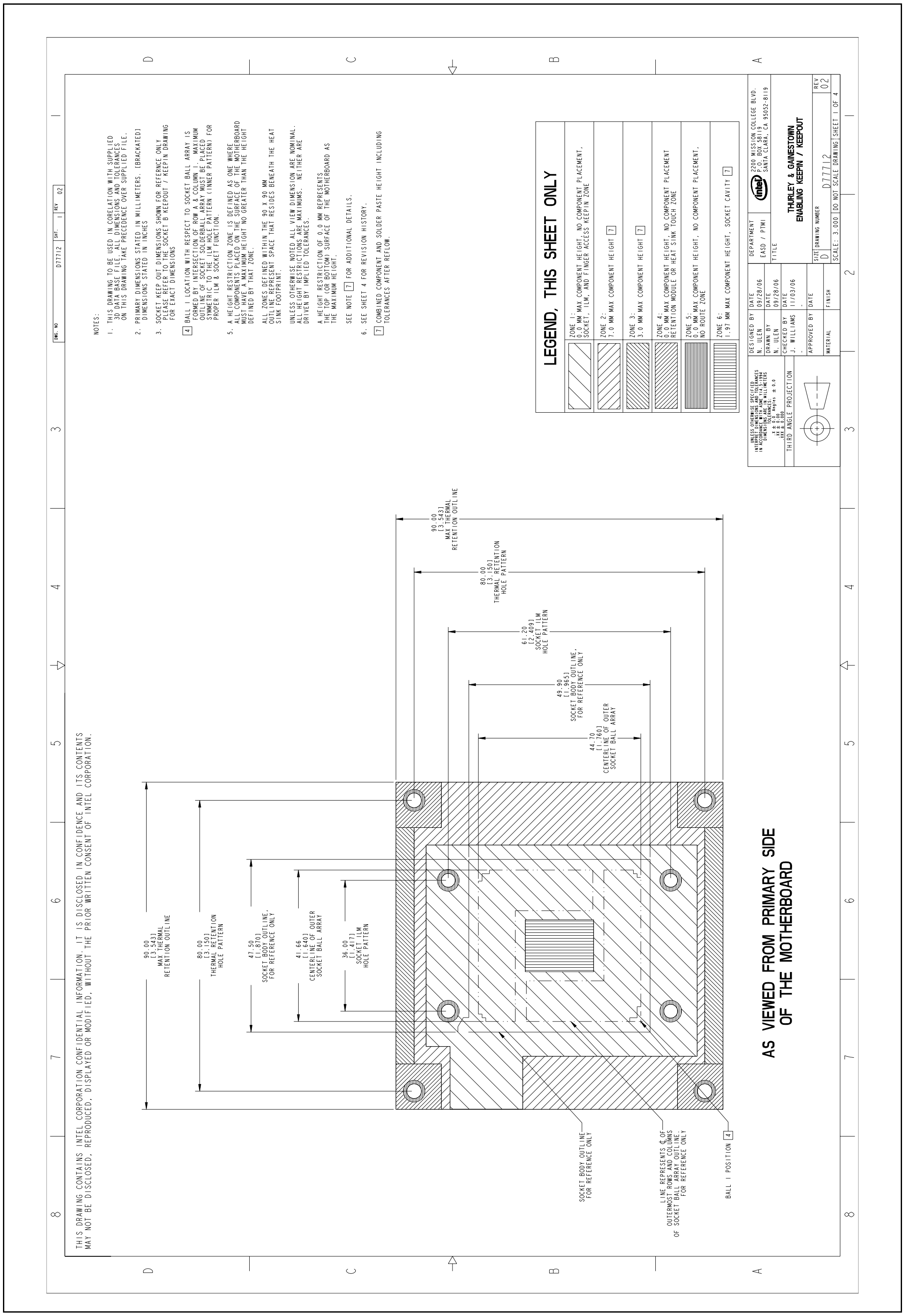


Figure B-2. Board Keepin / Keepout Zones (Sheet 2 of 4)

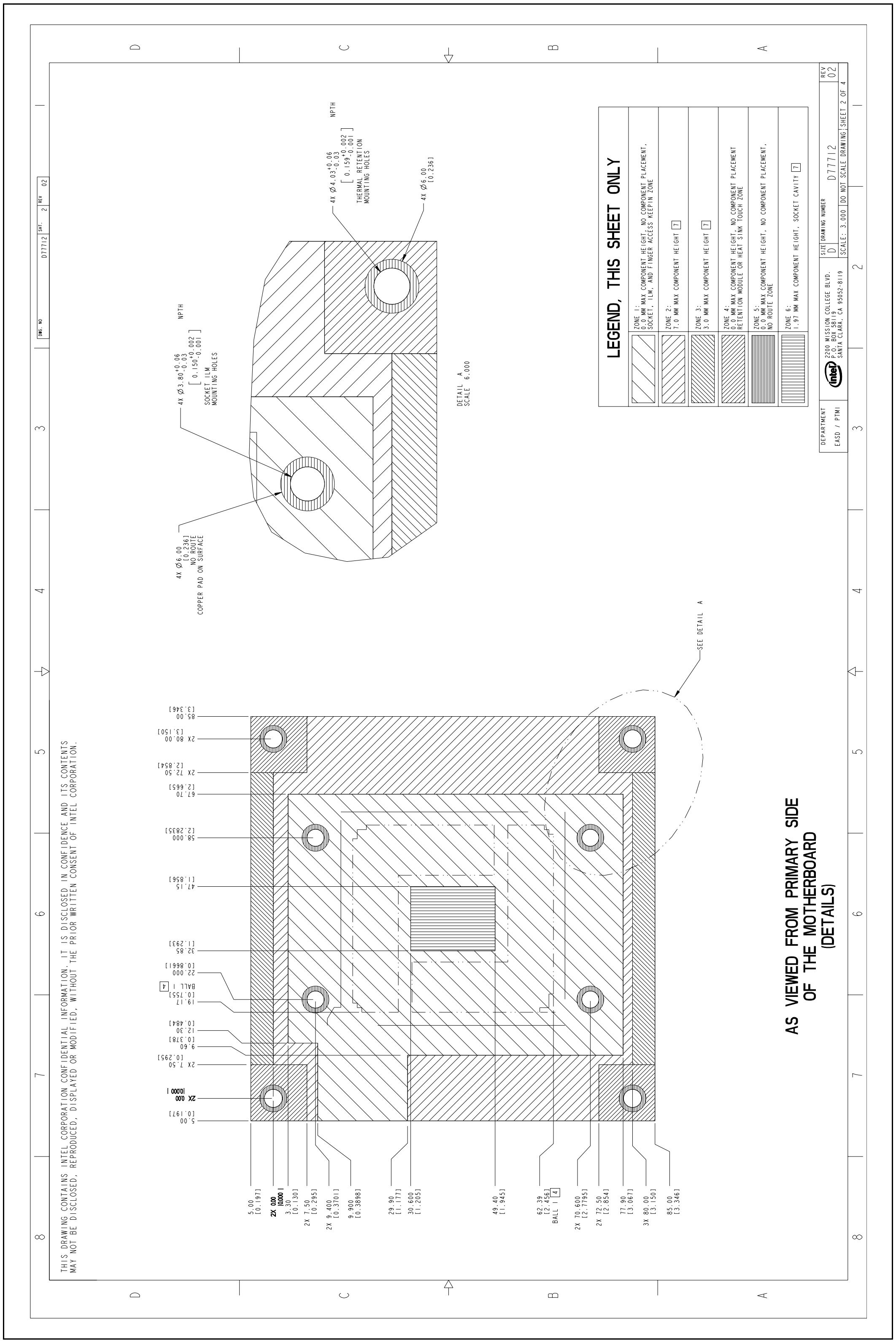


Figure B-3. Board Keepin / Keepout Zones (Sheet 3 of 4)

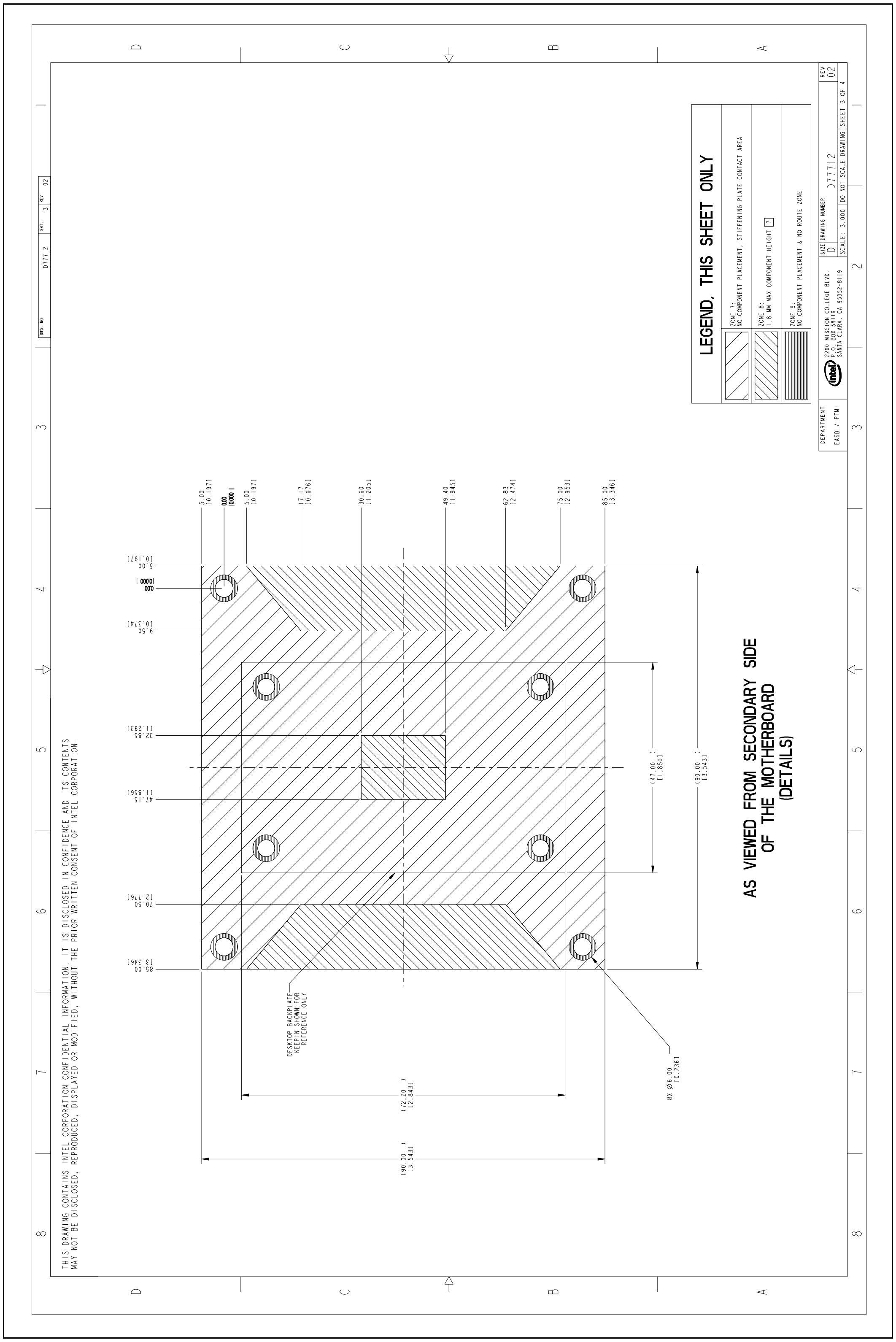


Figure B-4. Board Keepin / Keepout Zones (Sheet 4 of 4)

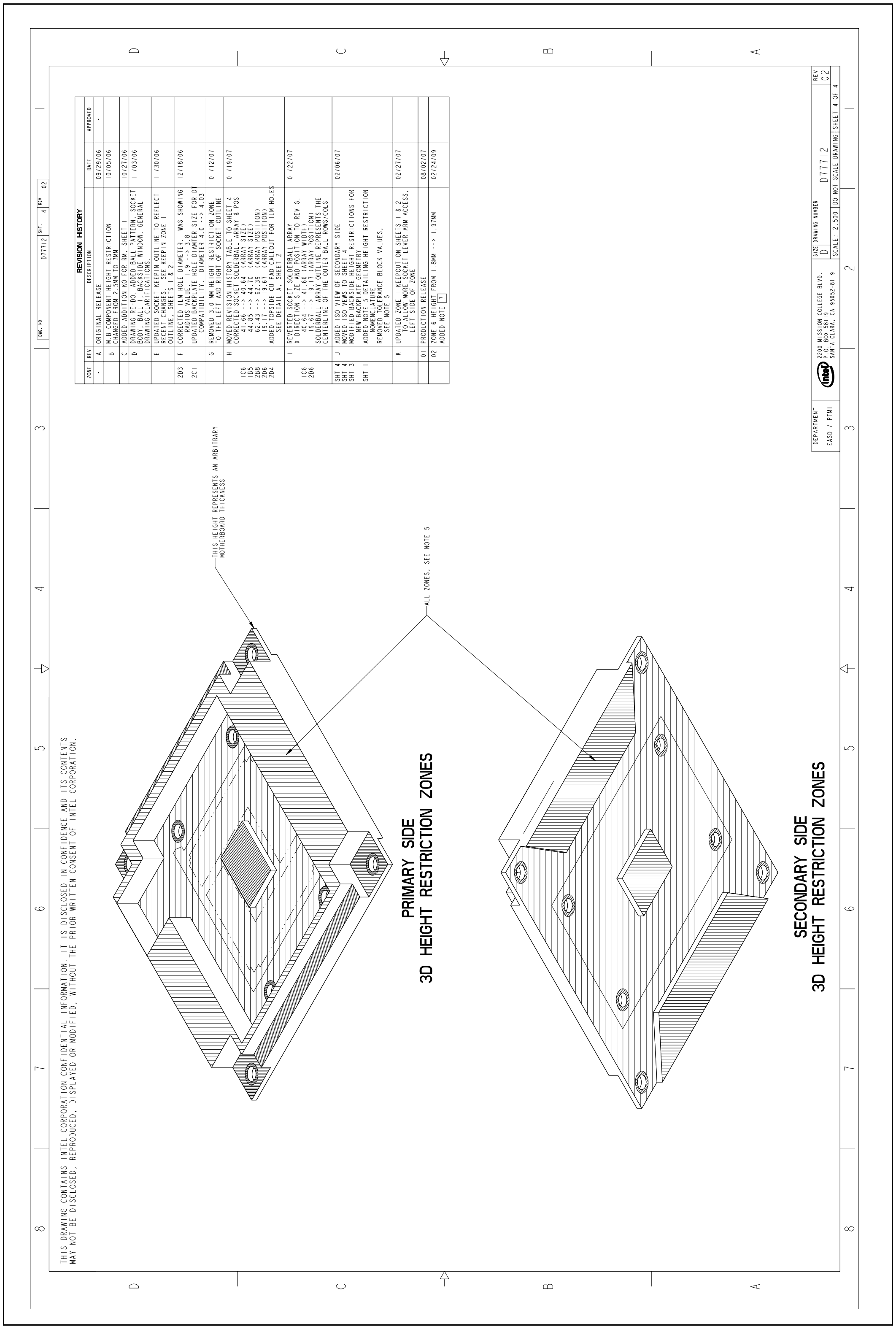


Figure B-5. 1U Reference Heatsink Assembly (Sheet 1 of 2)

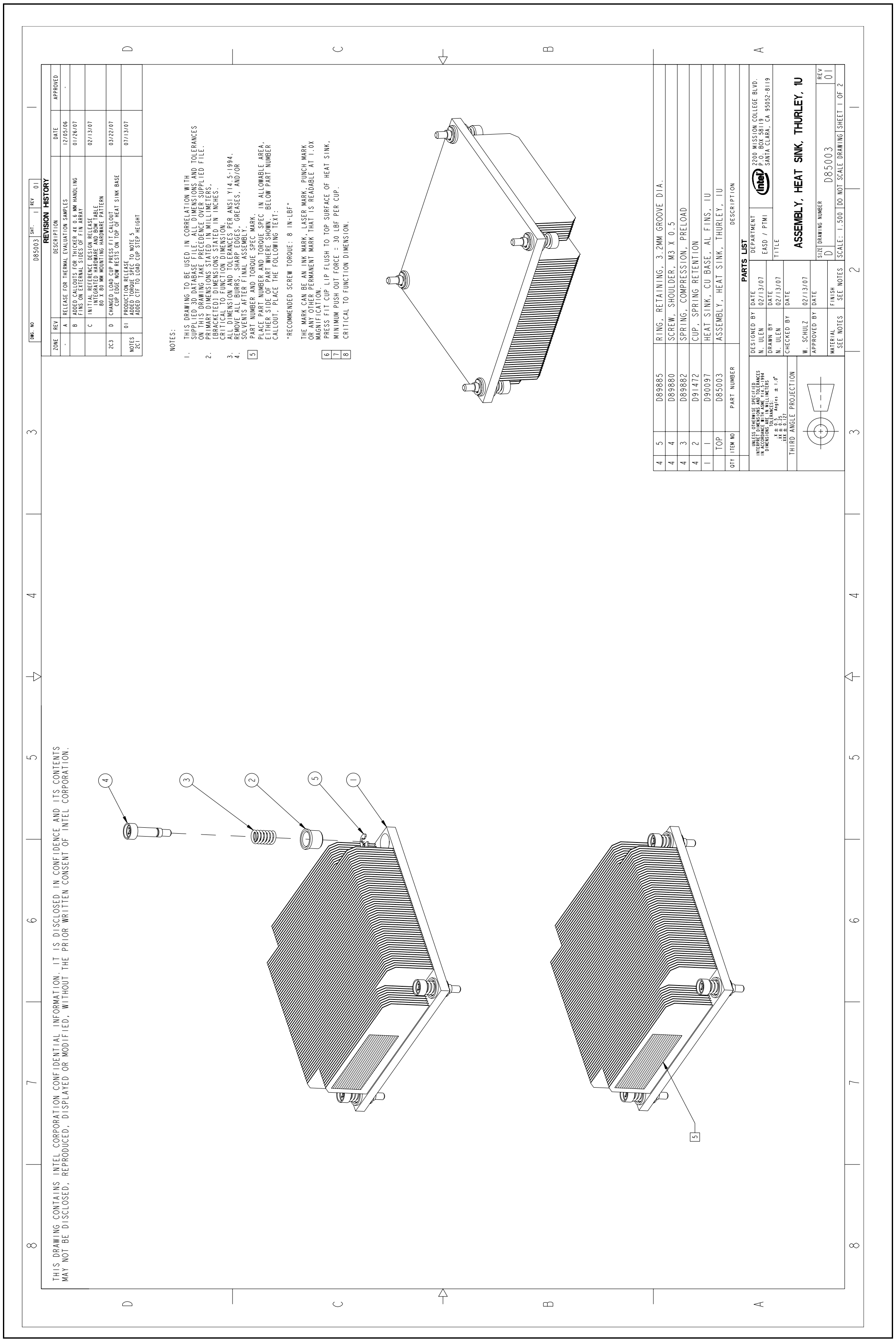


Figure B-6. 1U Reference Heatsink Assembly (Sheet 2 of 2)

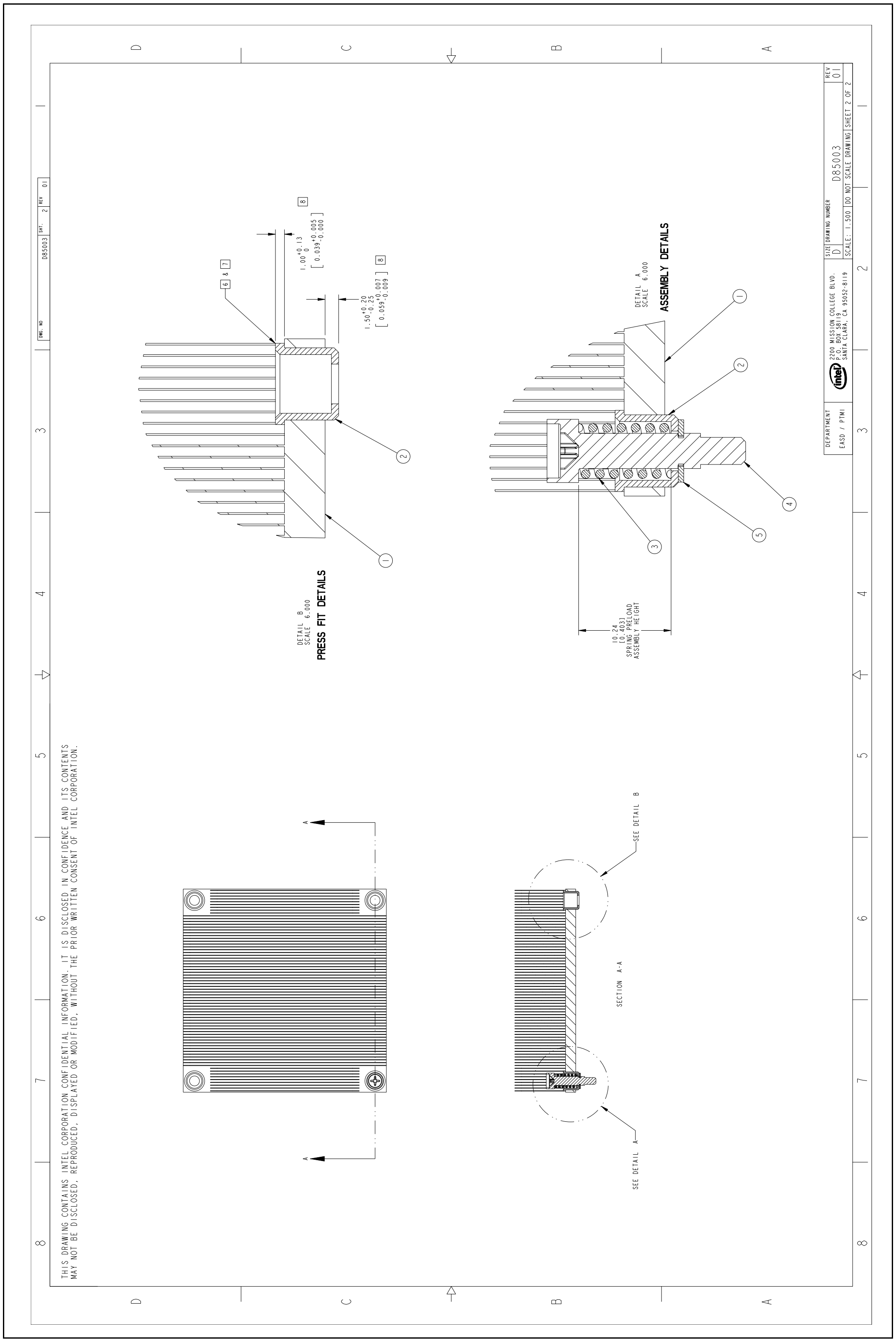


Figure B-7. 1U Reference Heatsink Fin and Base (Sheet 1 of 2)

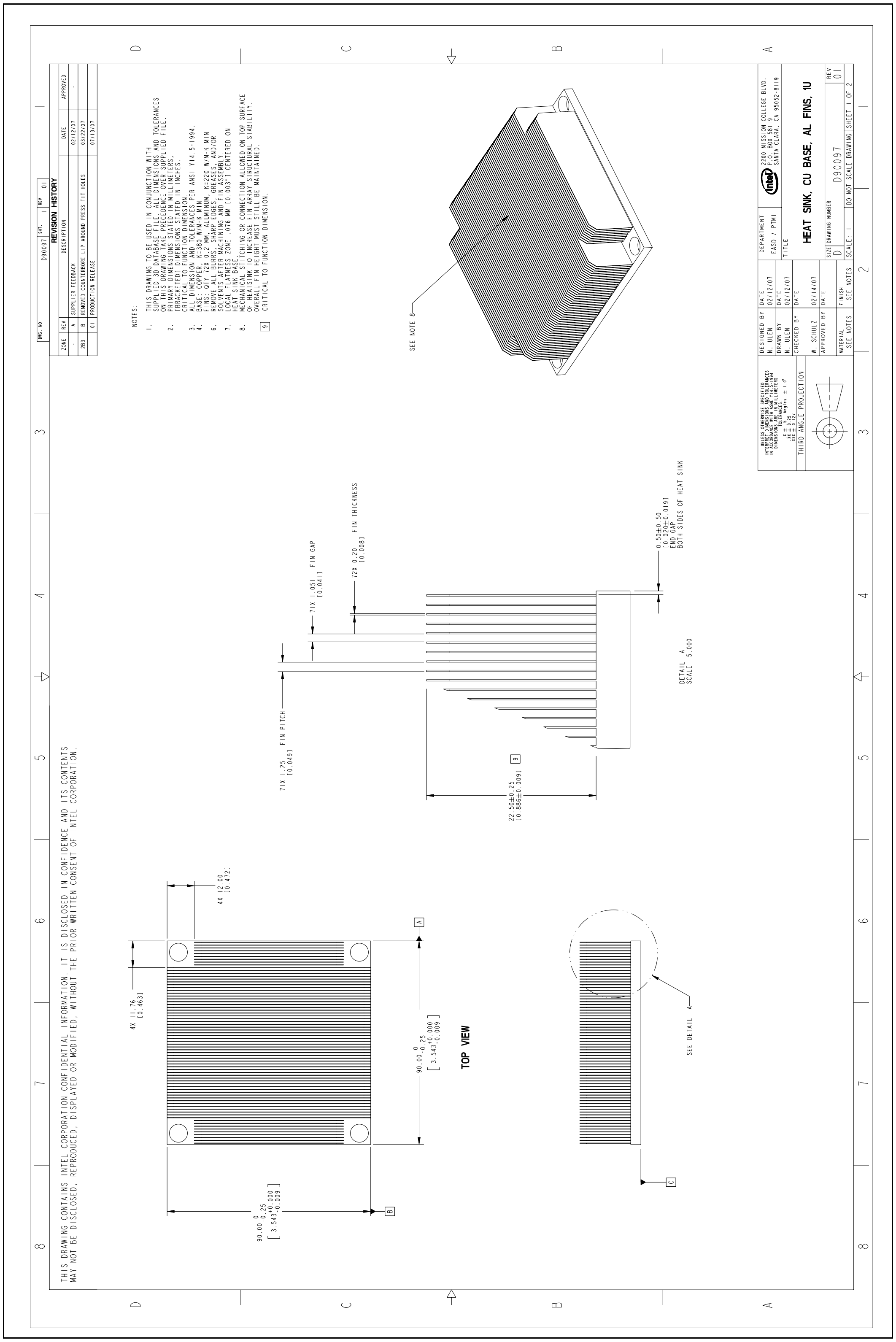


Figure B-8. 1U Reference Heatsink Fin and Base (Sheet 2 of 2)

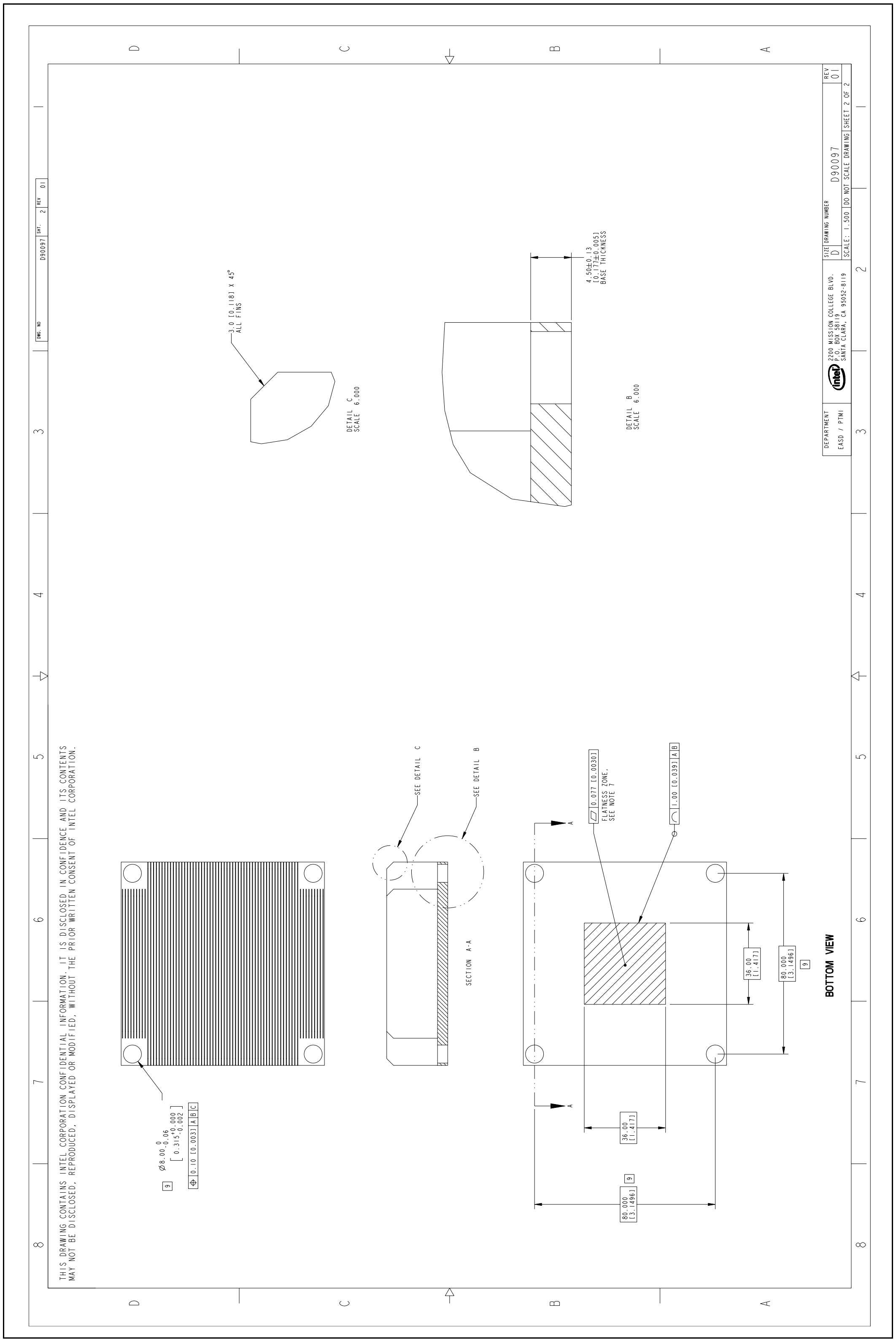


Figure B-9. Heatsink Shoulder Screw (1U, 2U and Tower)

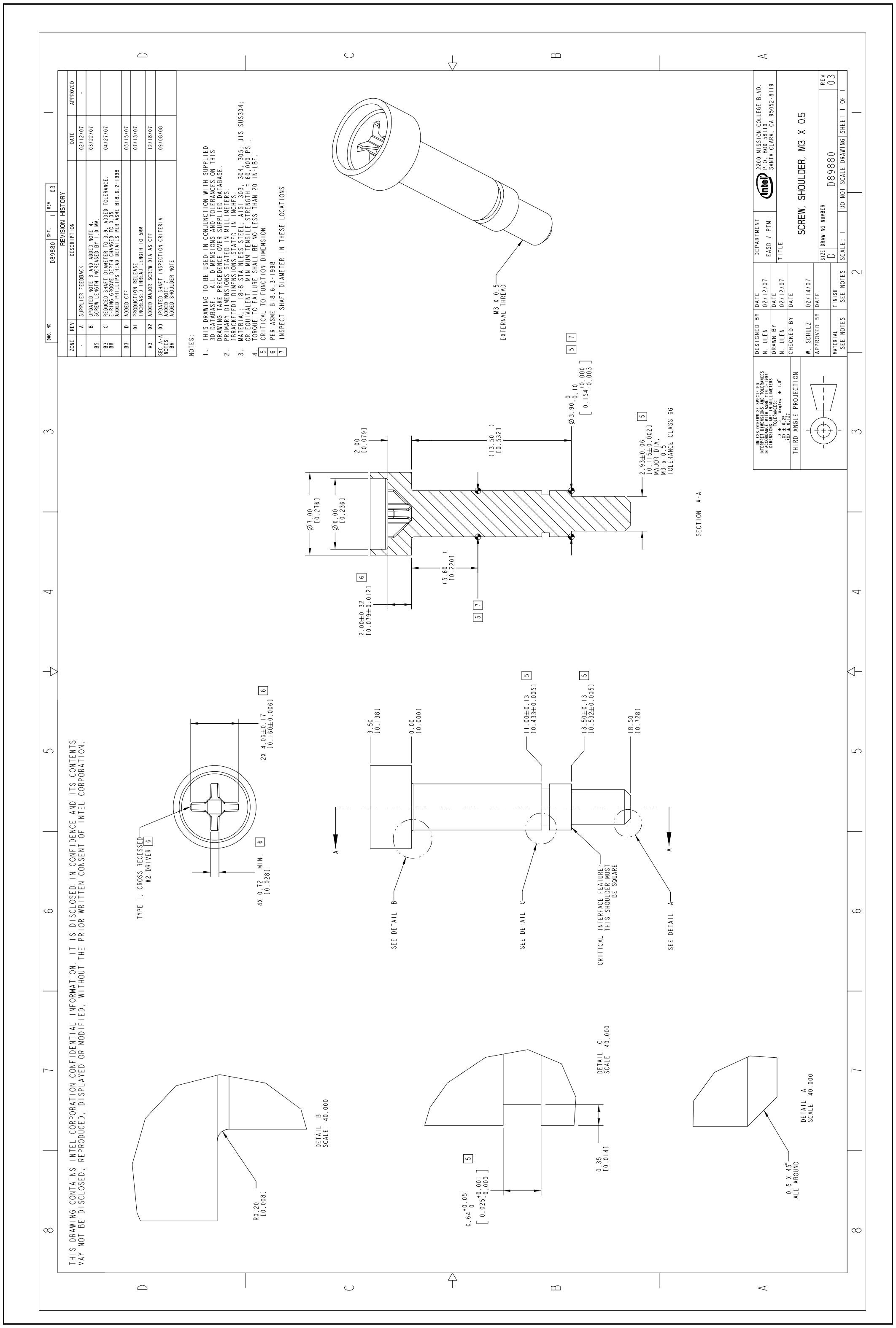


Figure B-10. Heatsink Compression Spring (1U, 2U and Tower)

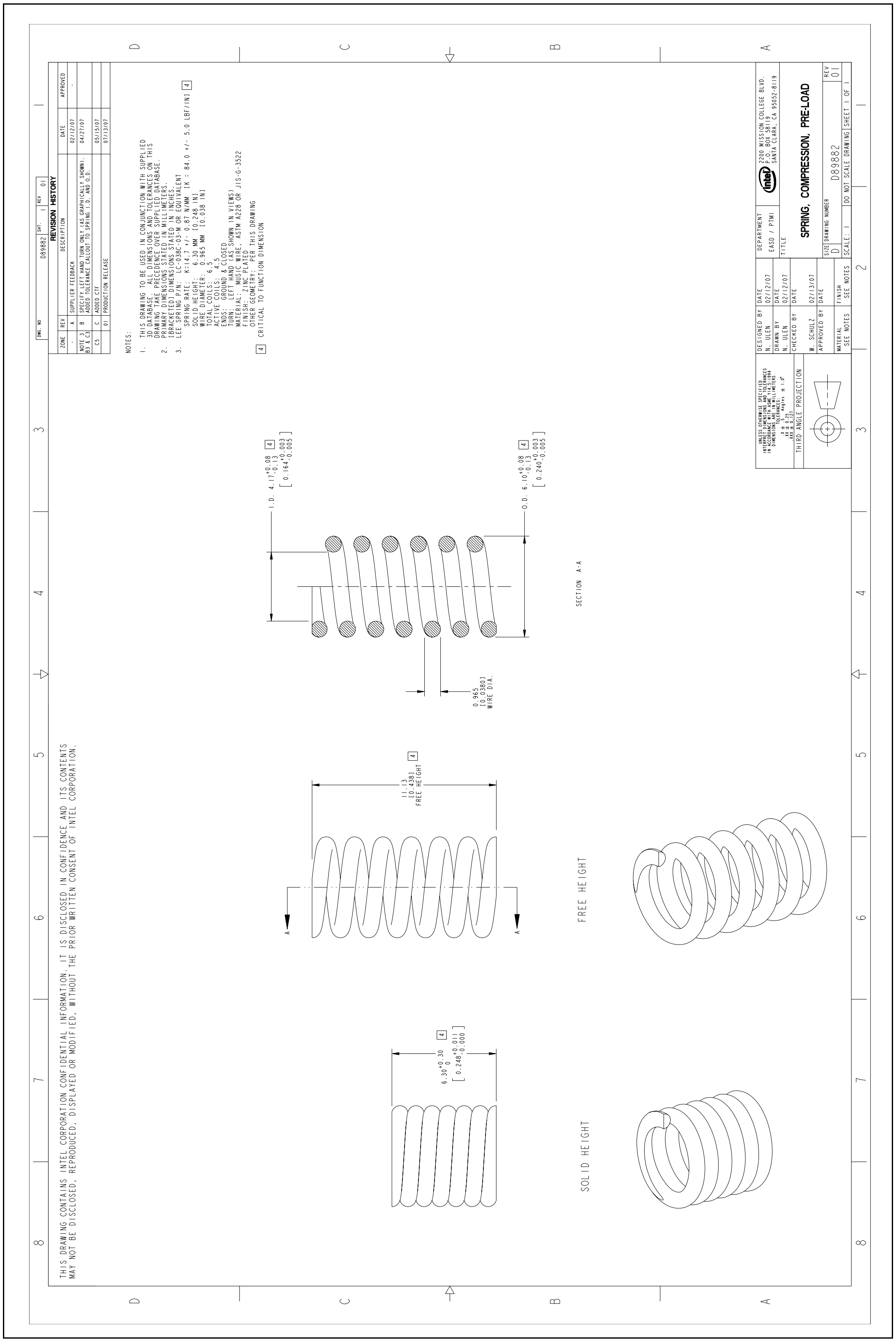


Figure B-11. Heatsink Retaining Ring (1U, 2U and Tower)

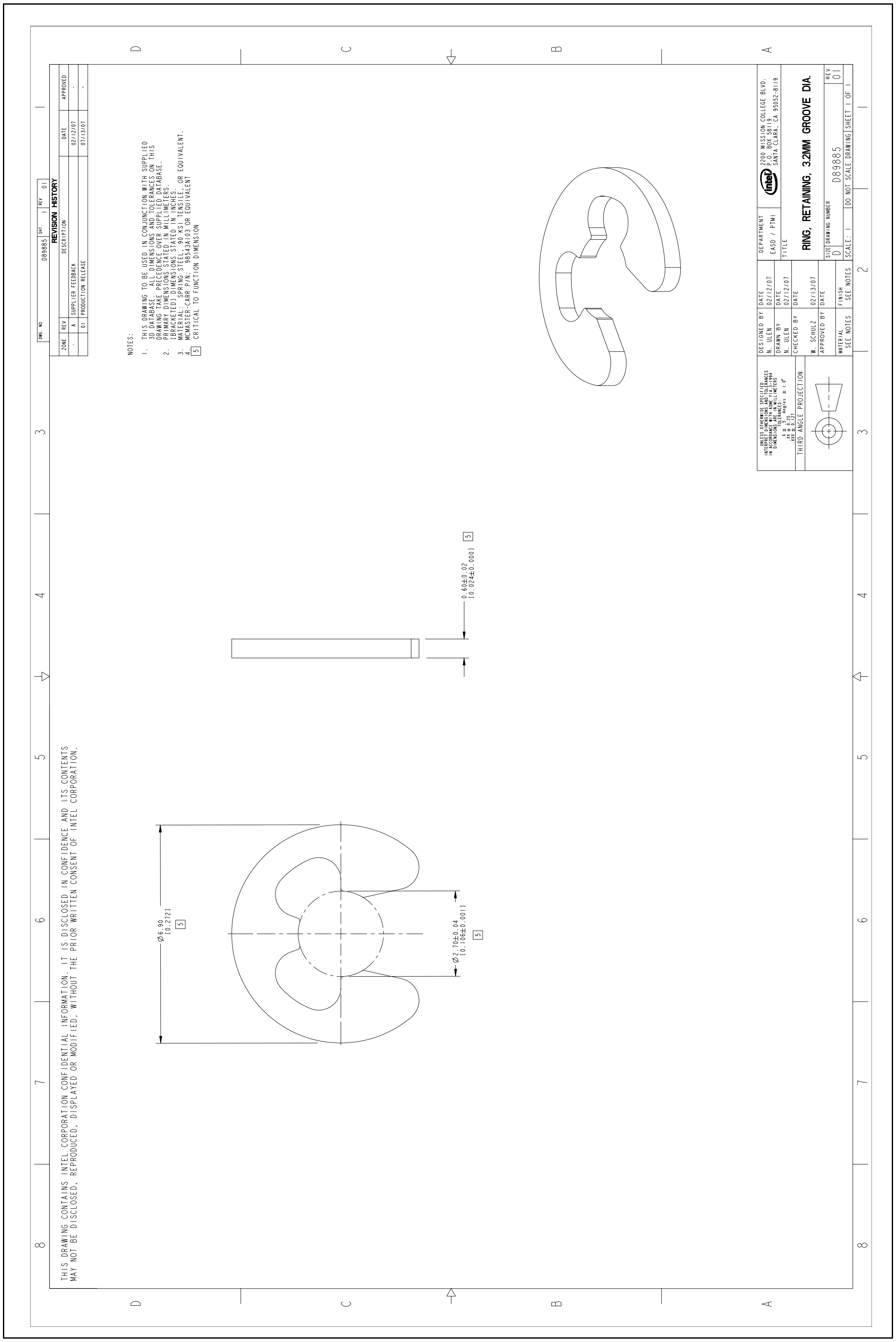


Figure B-12. Heatsink Load Cup (1U, 2U and Tower)

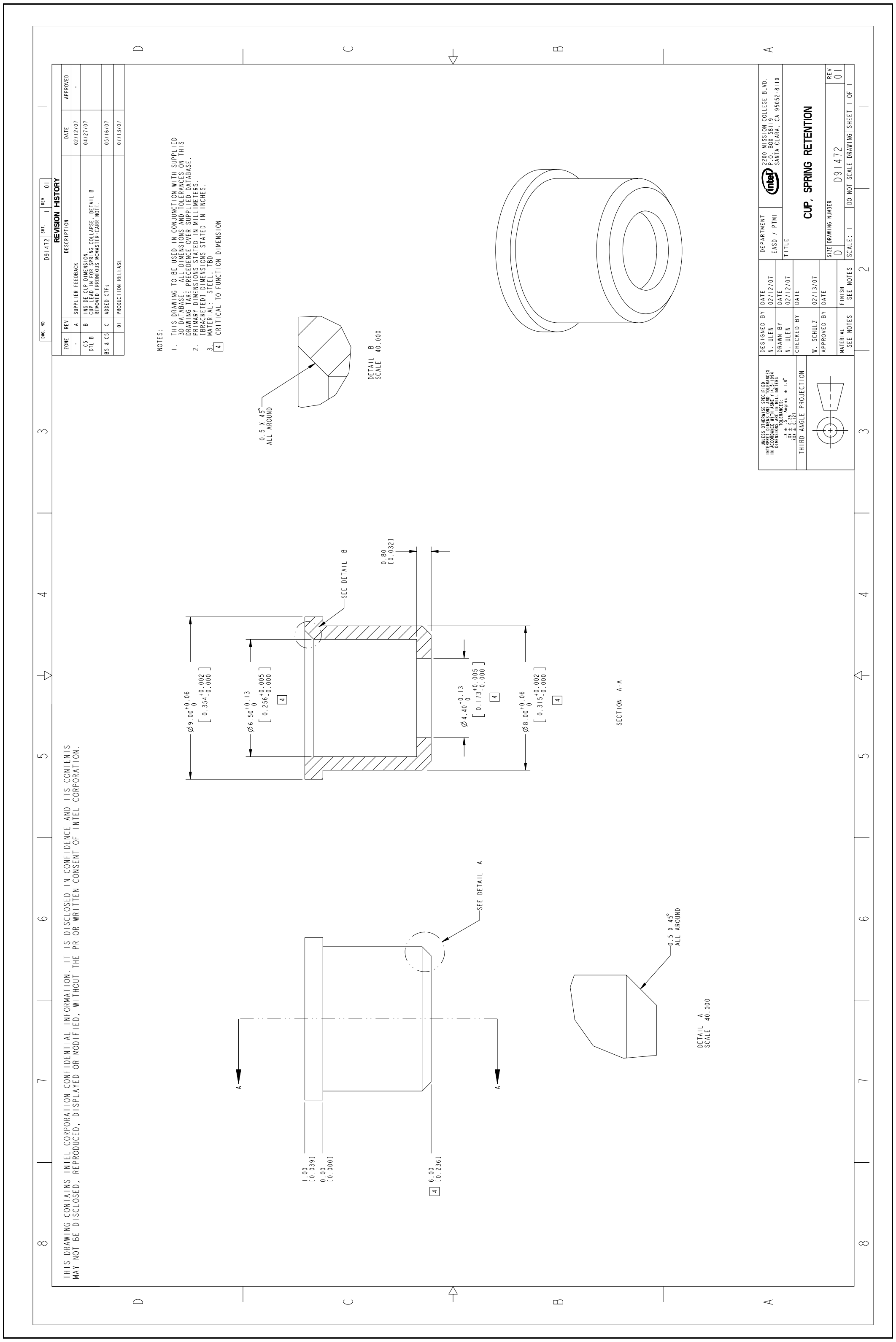


Figure B-13. 2U Collaborative Heatsink Assembly (Sheet 1 of 2)

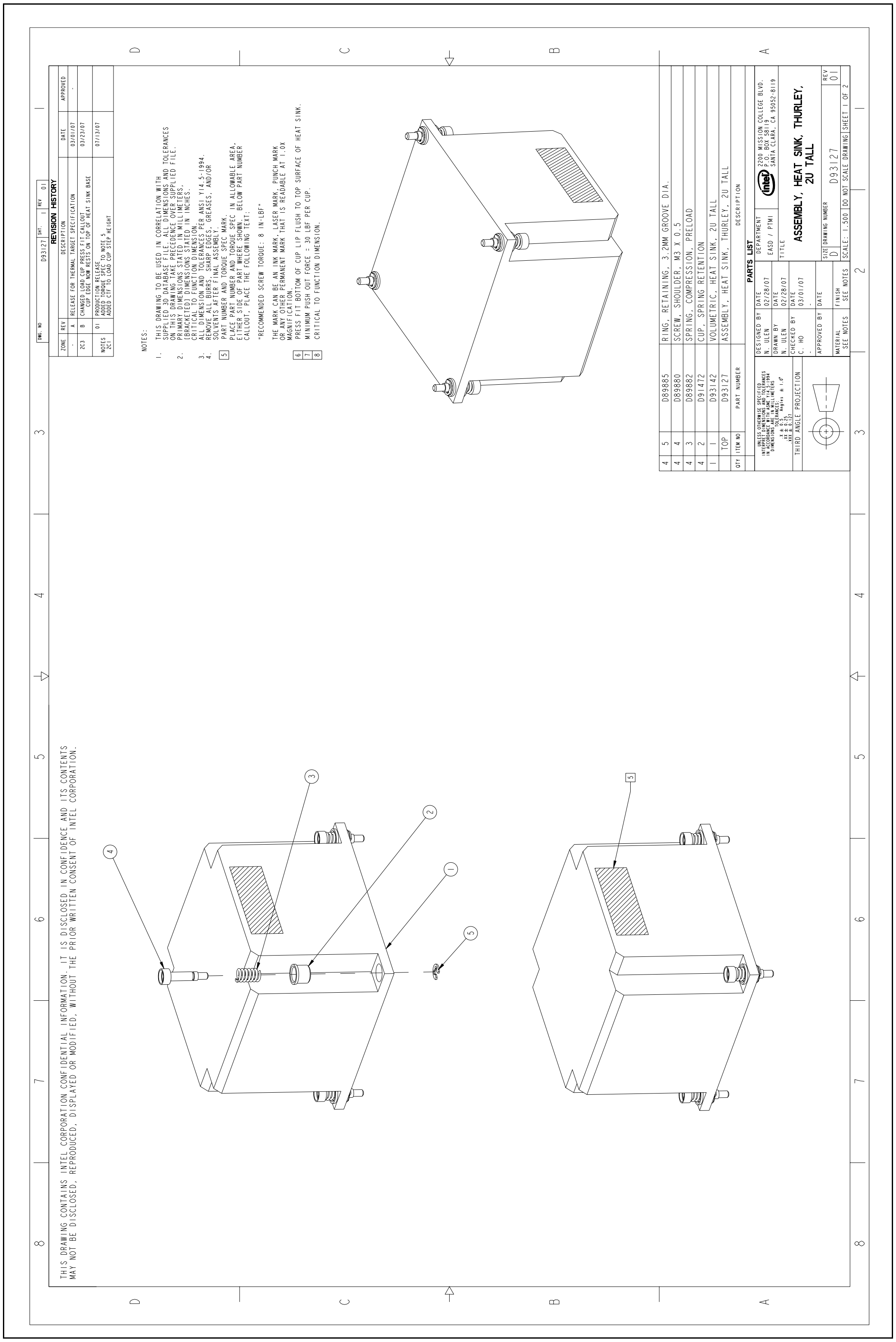


Figure B-14. 2U Collaborative Heatsink Assembly (Sheet 2 of 2)

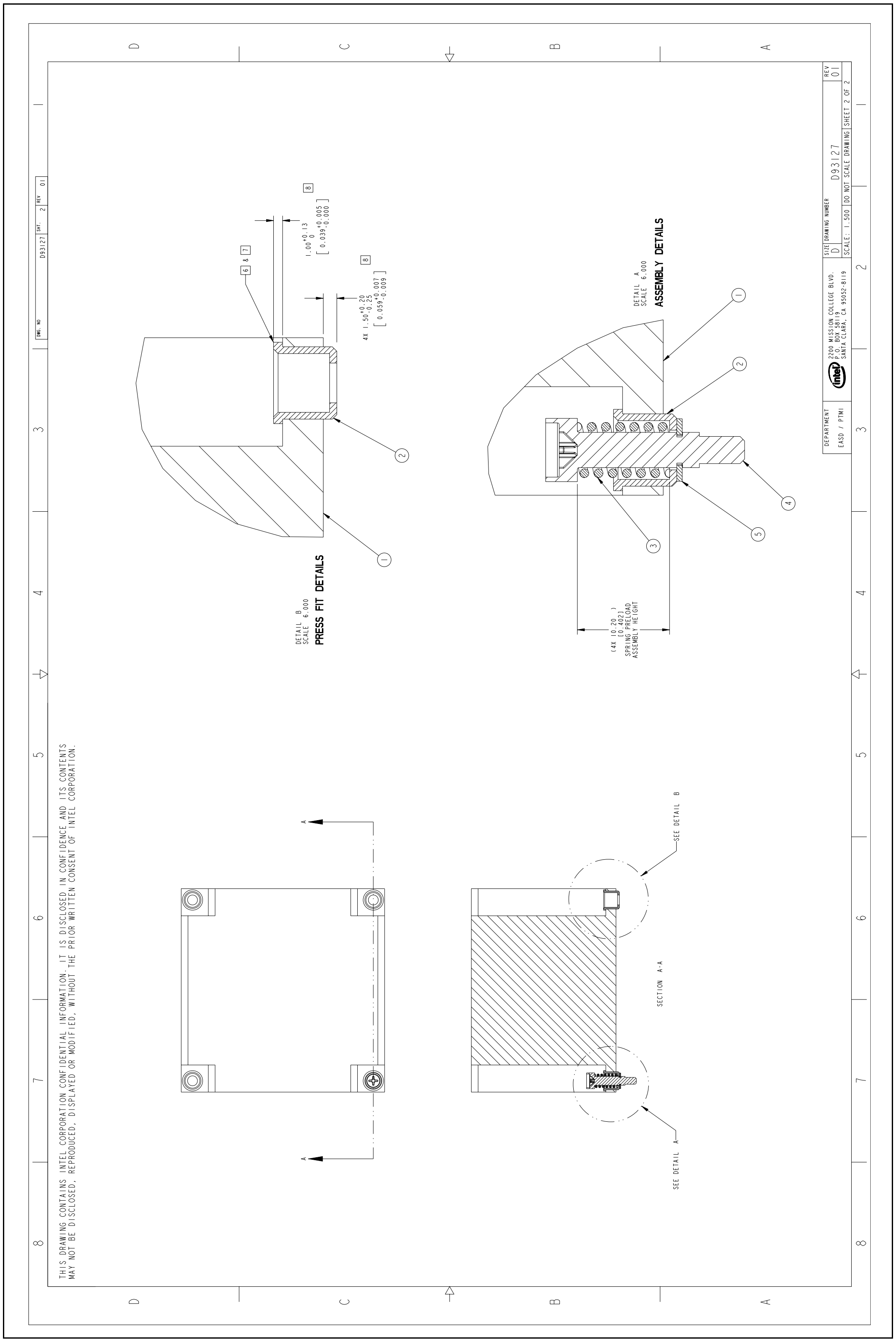


Figure B-15. 2U Collaborative Heatsink Volumetric (Sheet 1 of 2)

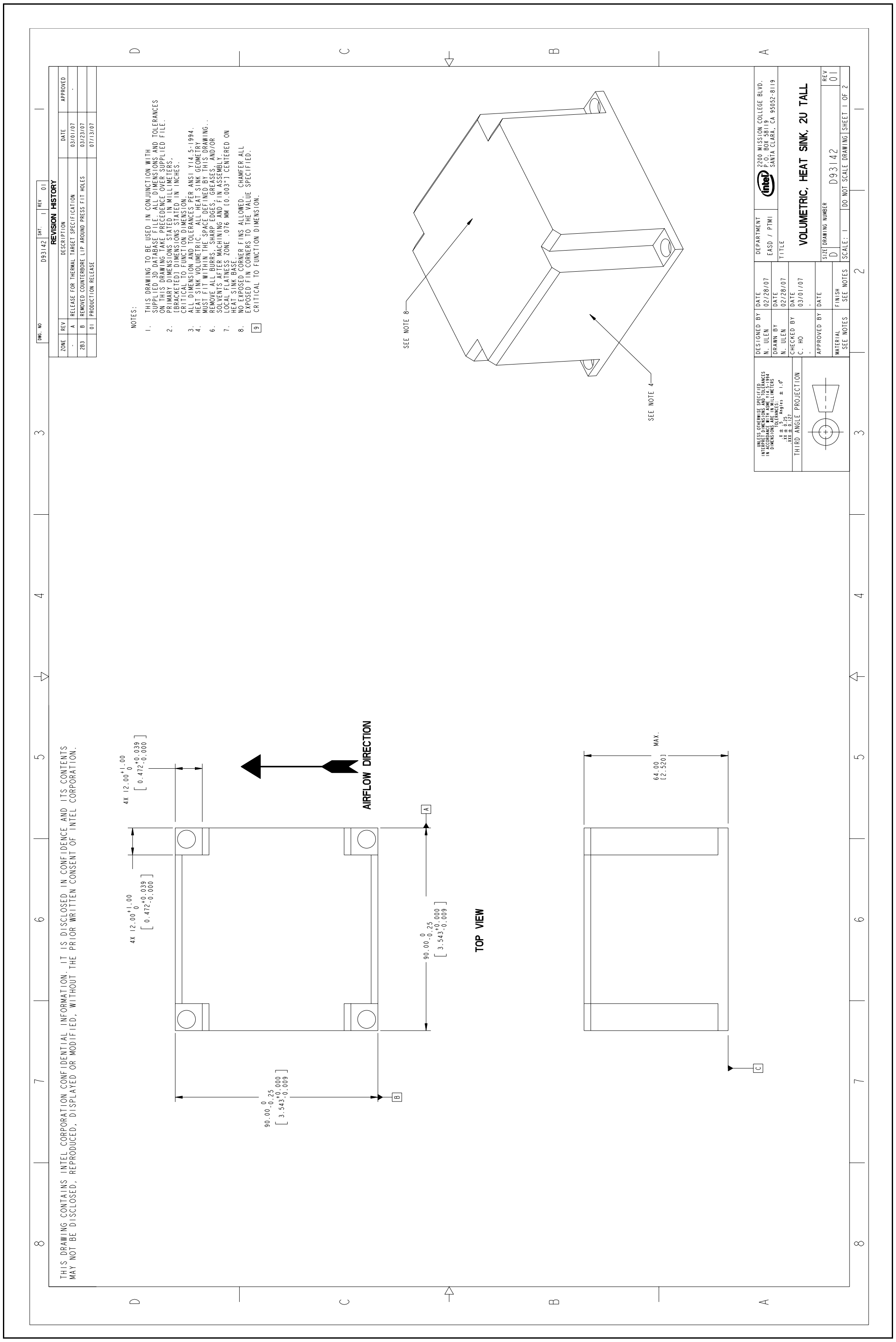


Figure B-16. 2U Collaborative Heatsink Volumetric (Sheet 2 of 2)

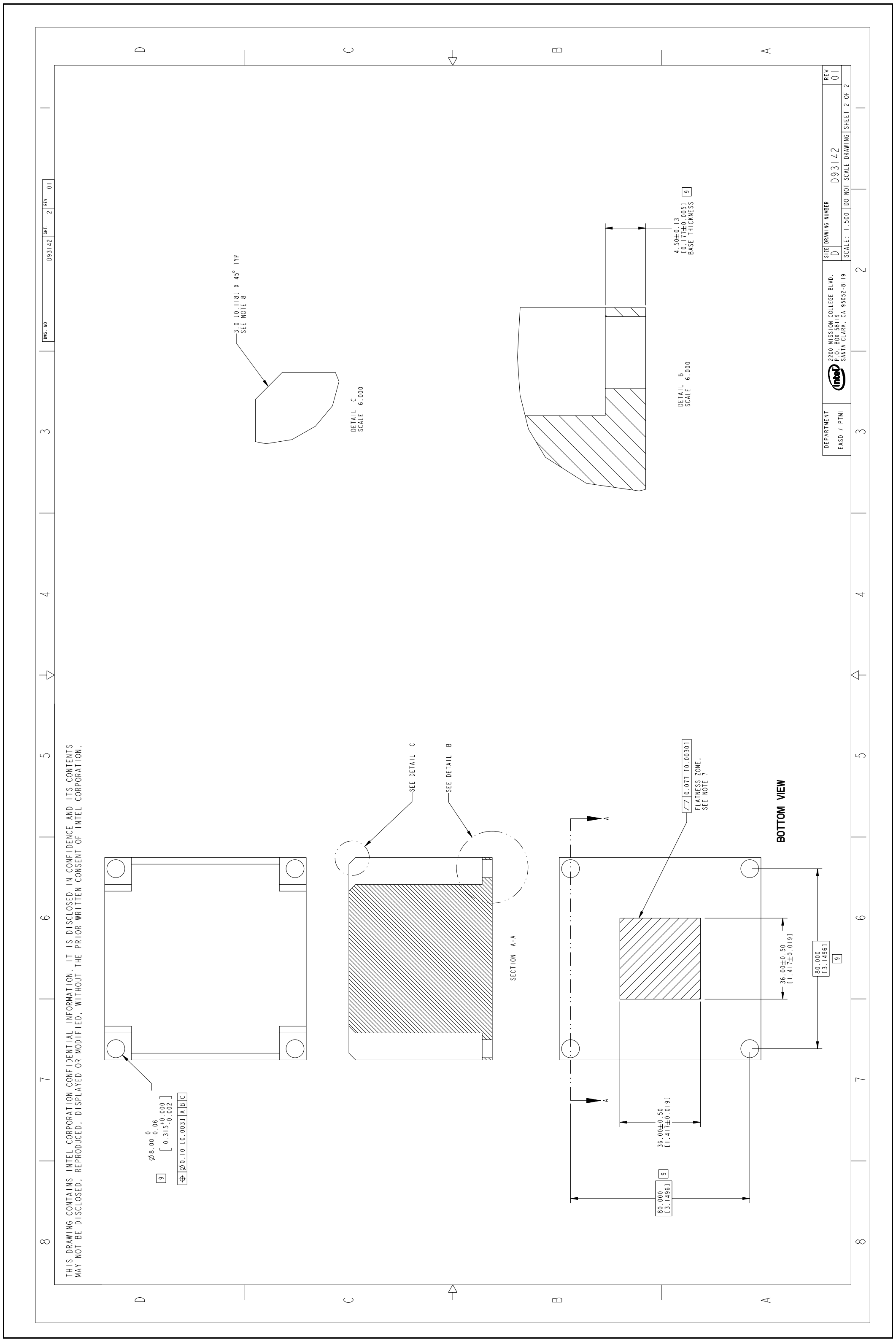


Figure B-17. Tower Collaborative Heatsink Assembly (Sheet 1 of 2)

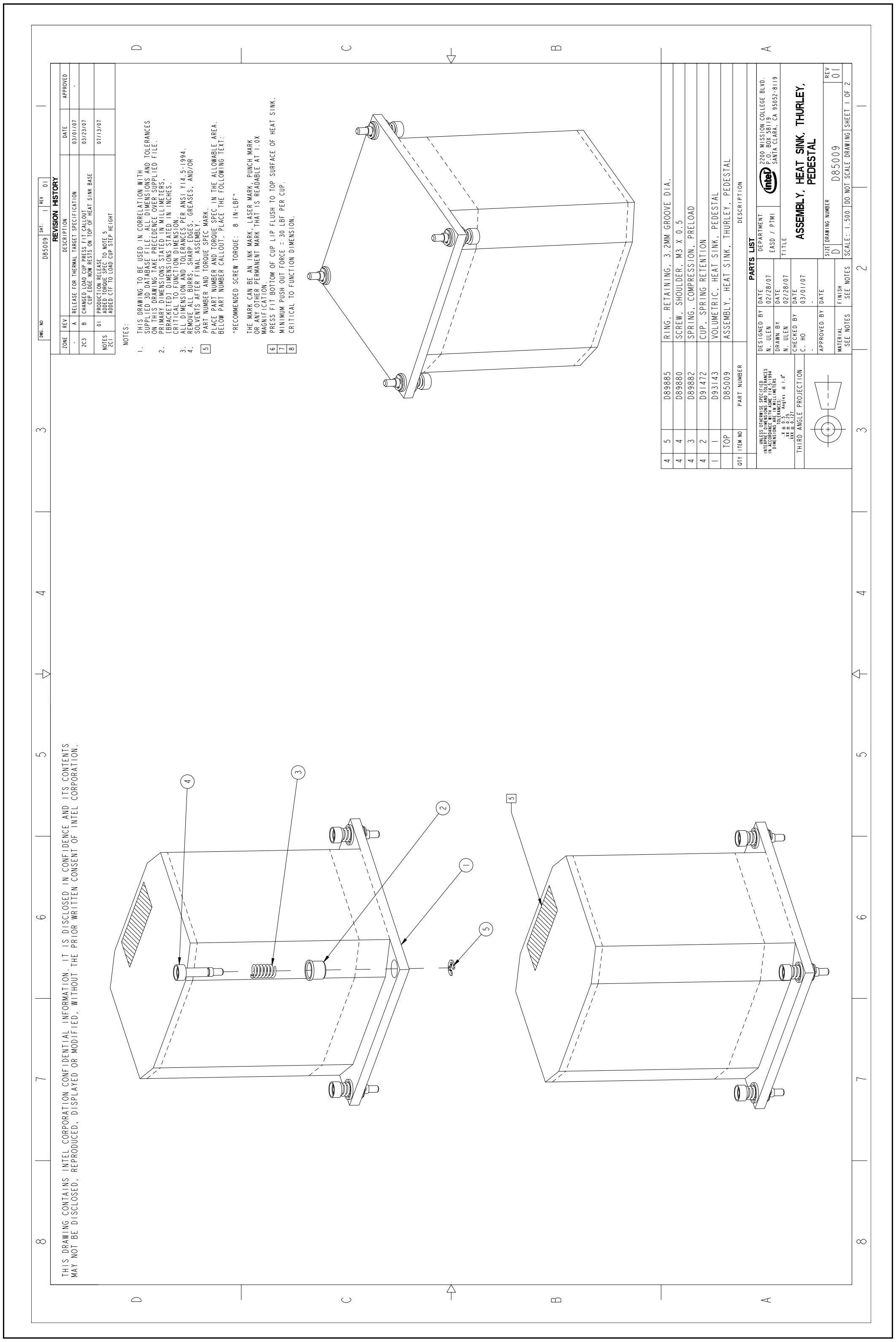


Figure B-18. Tower Collaborative Heatsink Assembly (Sheet 2 of 2)

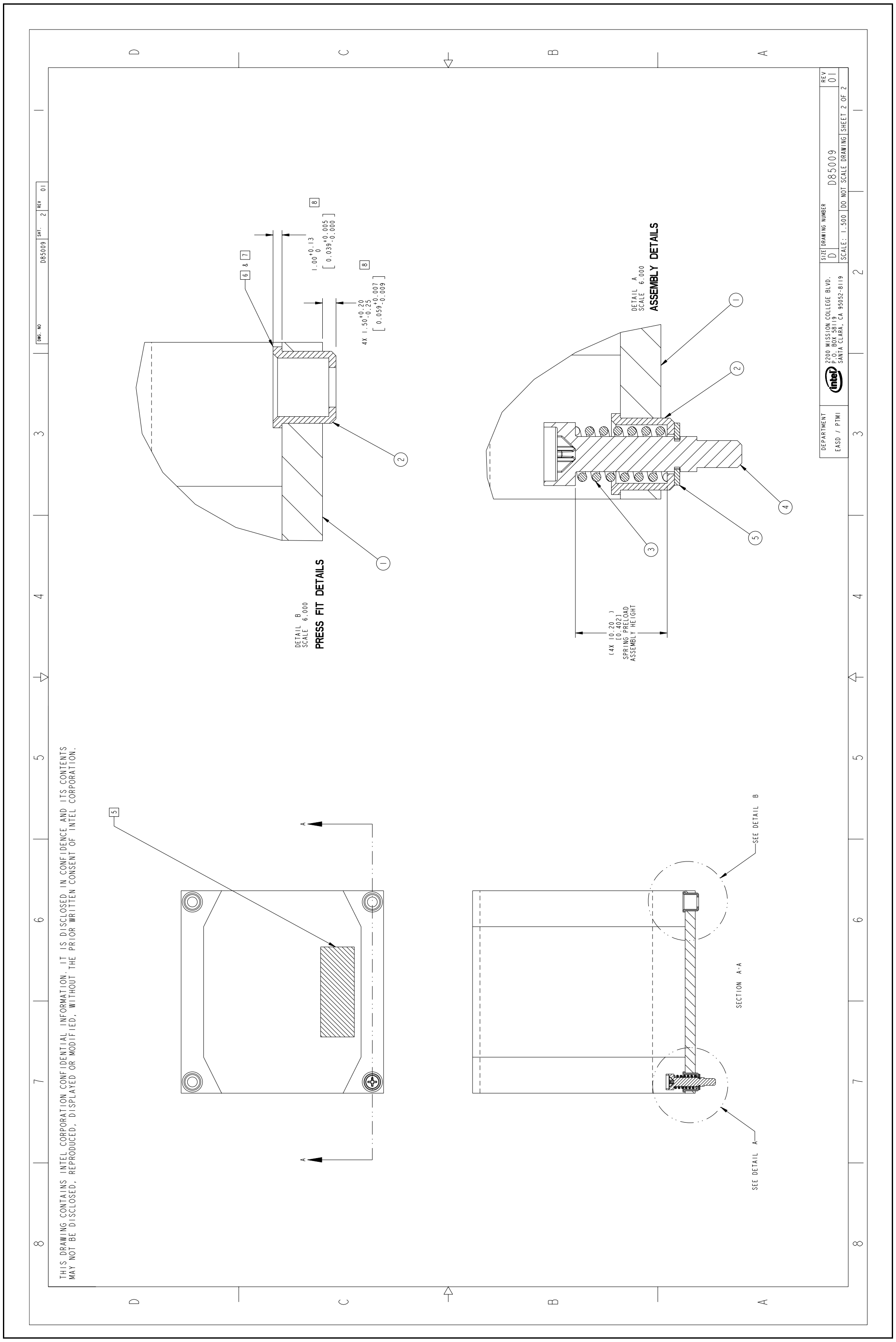


Figure B-19. Tower Collaborative Heatsink Volumetric (Sheet 1 of 2)

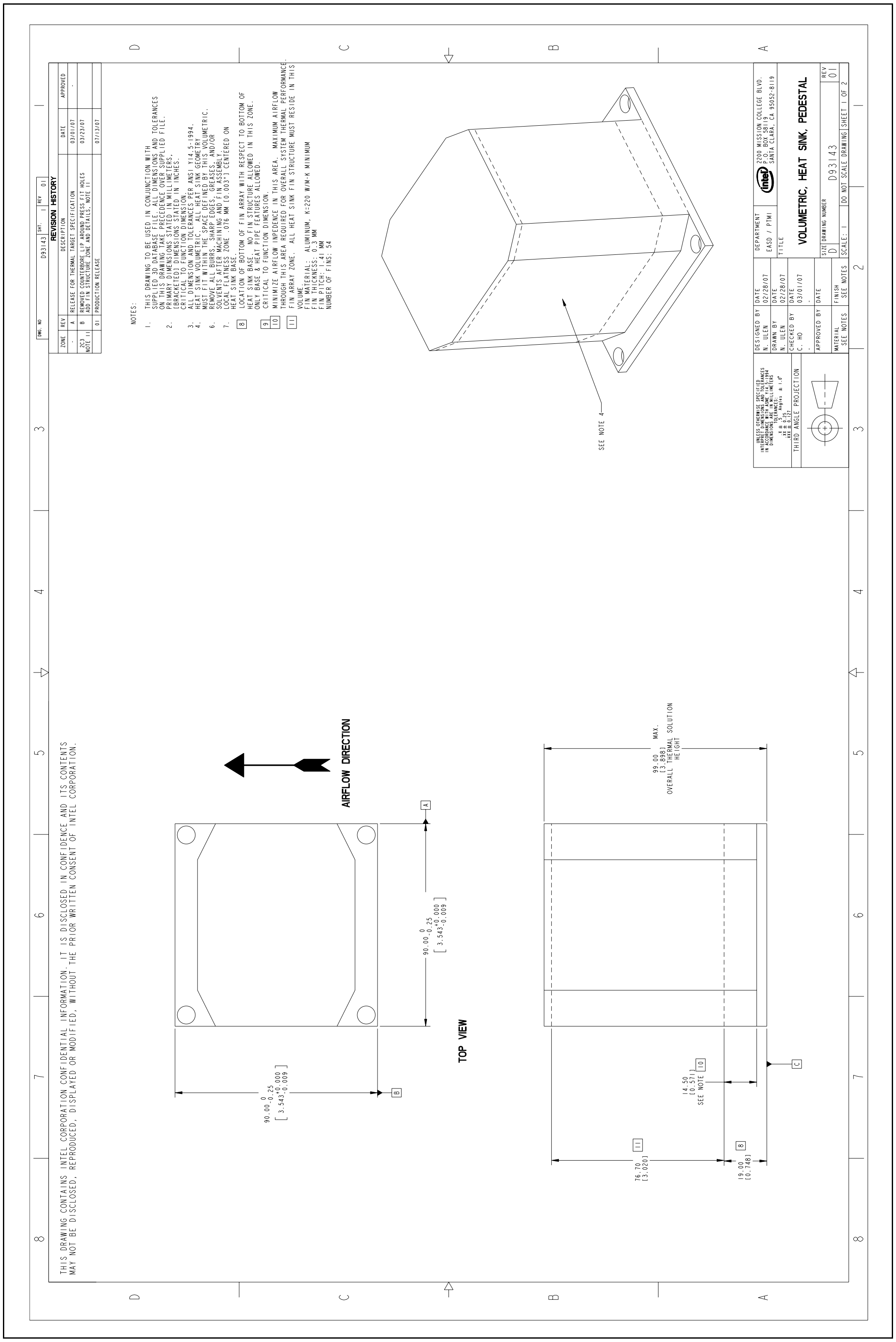


Figure B-20. Tower Collaborative Heatsink Volumetric (Sheet 2 of 2)

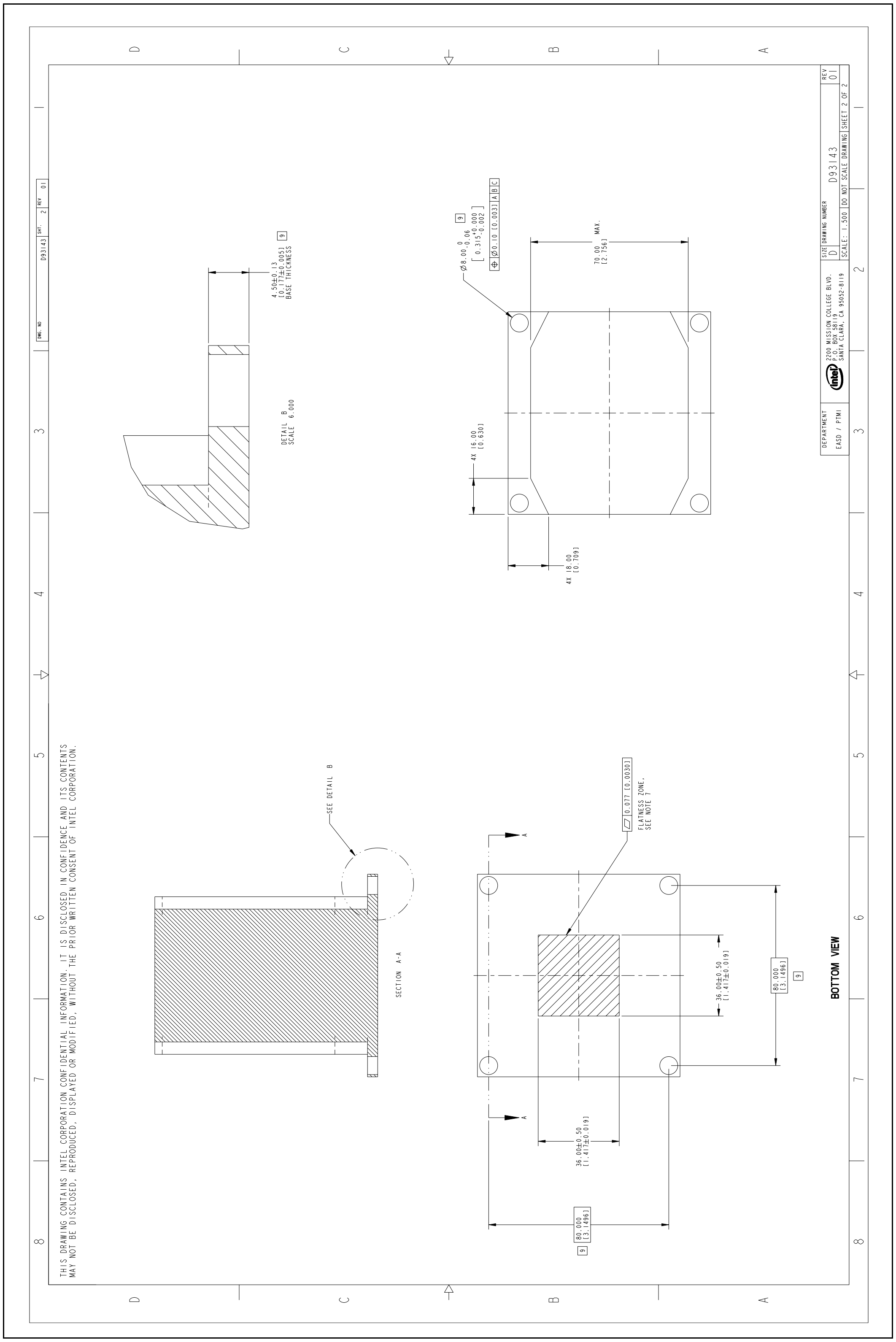


Figure B-21. 1U Reference Heatsink Assembly with TIM (Sheet 1 of 2)

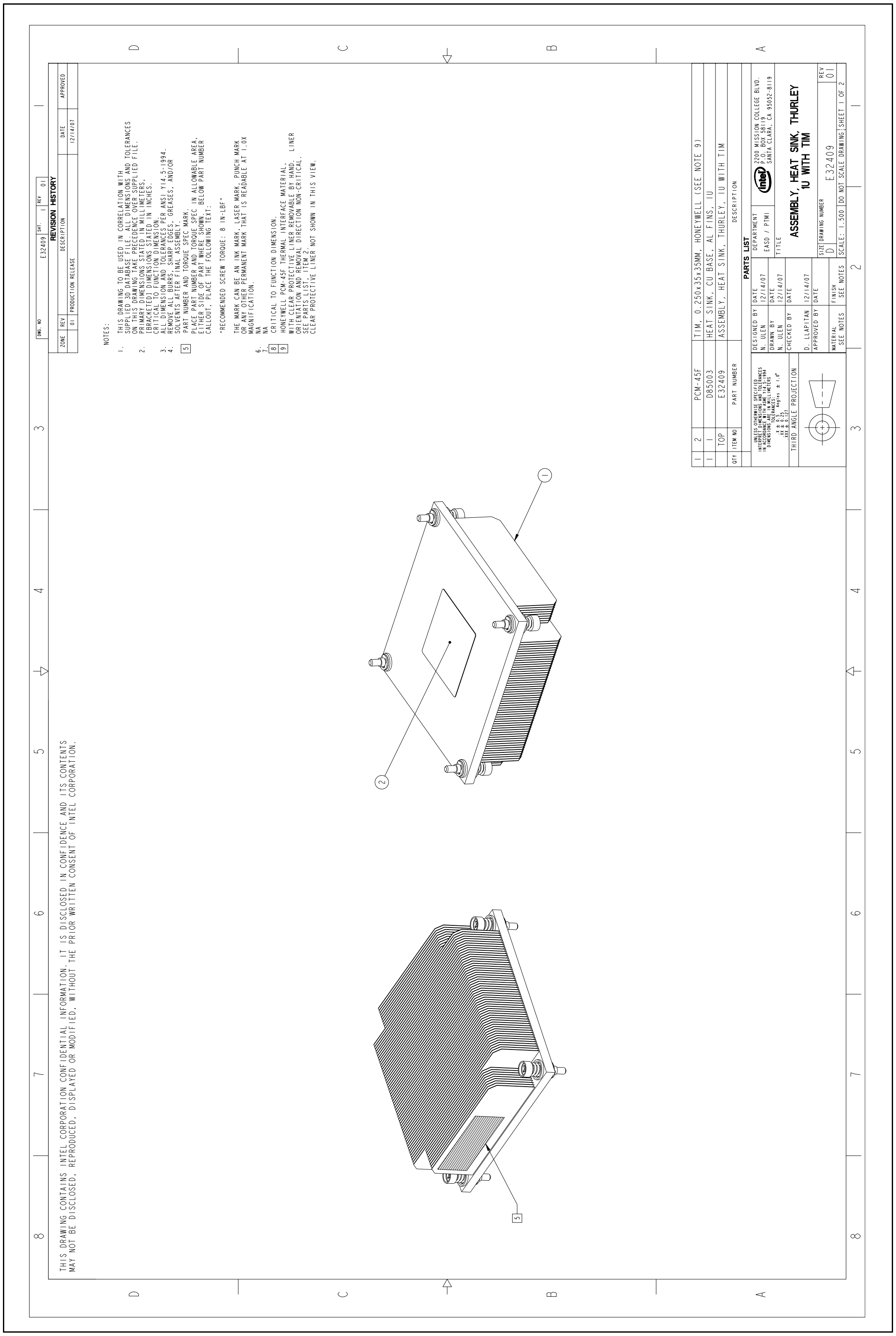


Figure B-22. 1U Reference Heatsink Assembly with TIM (Sheet 2 of 2)

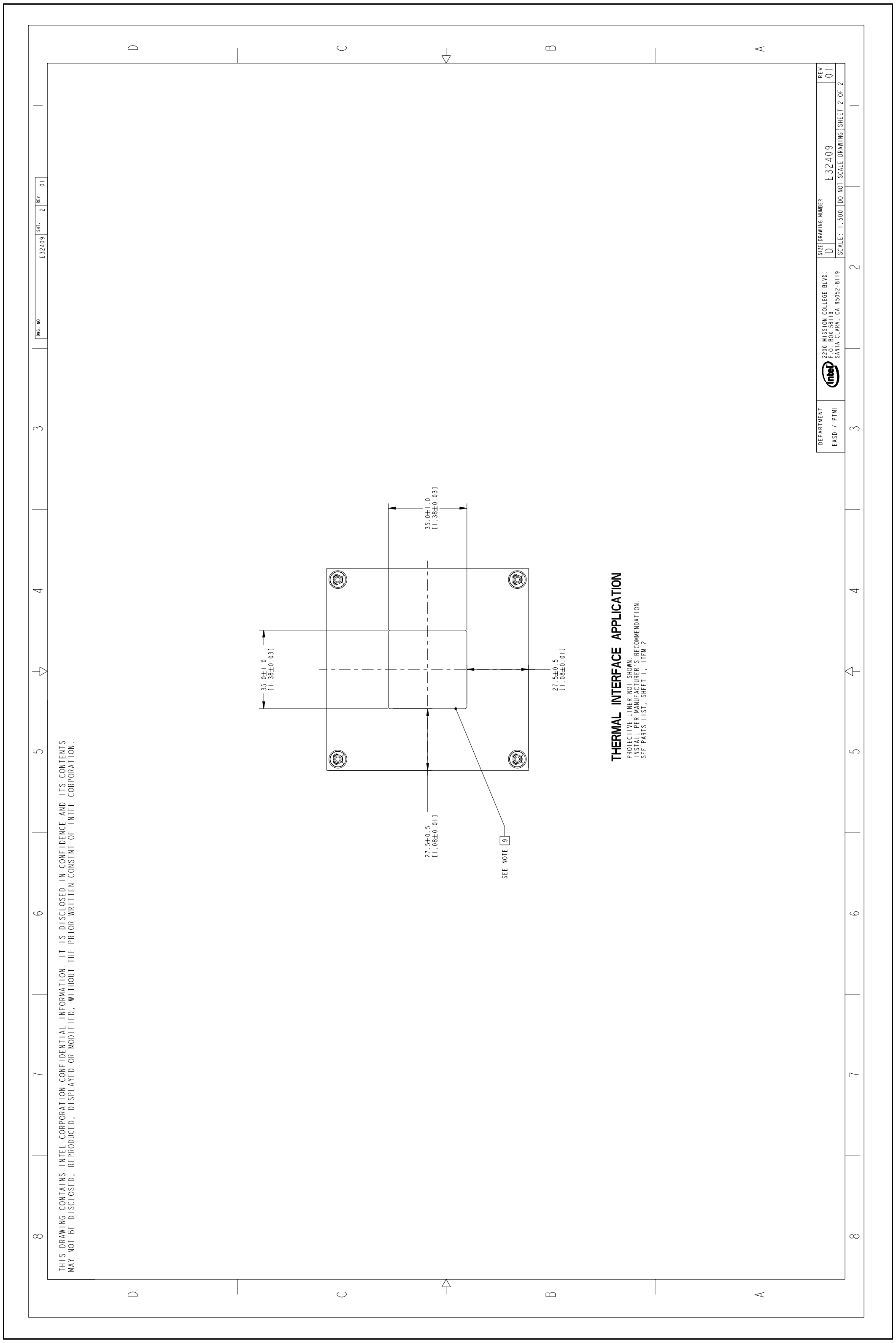


Figure B-23. 2U Reference Heatsink Assembly with TIM (Sheet 1 of 2)

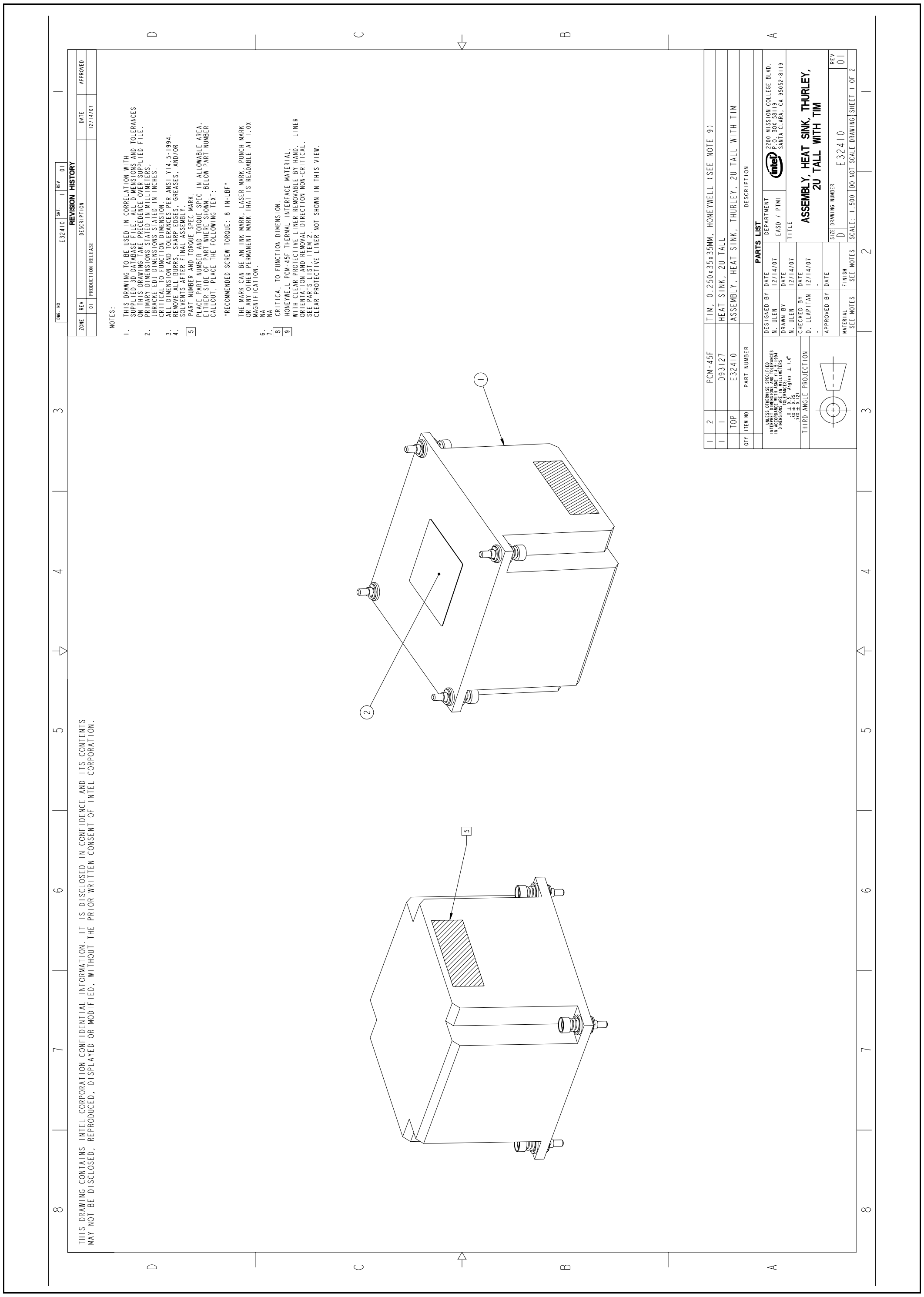


Figure B-24. 2U Reference Heatsink Assembly with TIM (Sheet 2 of 2)

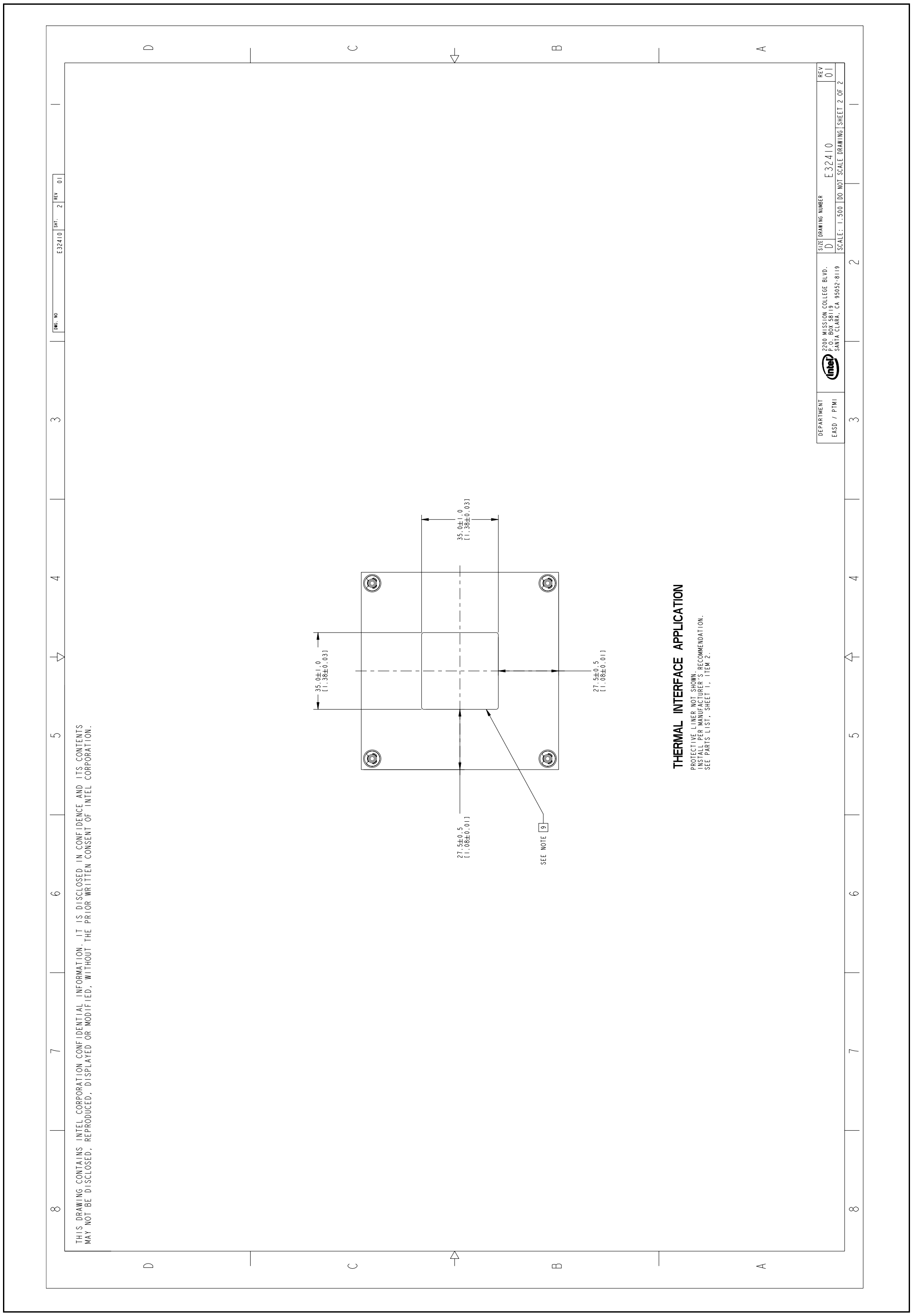


Figure B-25. Tower Reference Heatsink Assembly with TIM (Sheet 1 of 2)

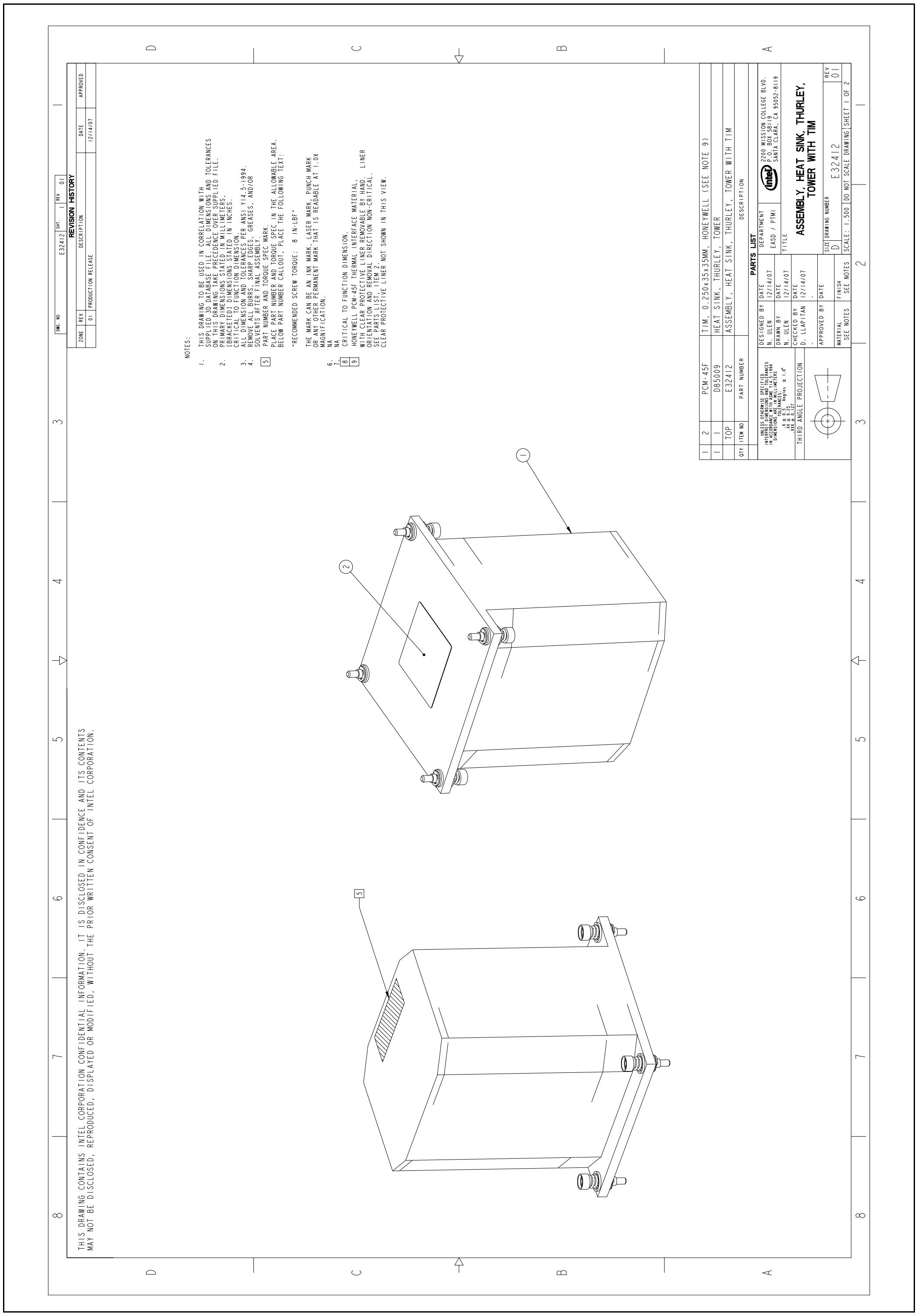
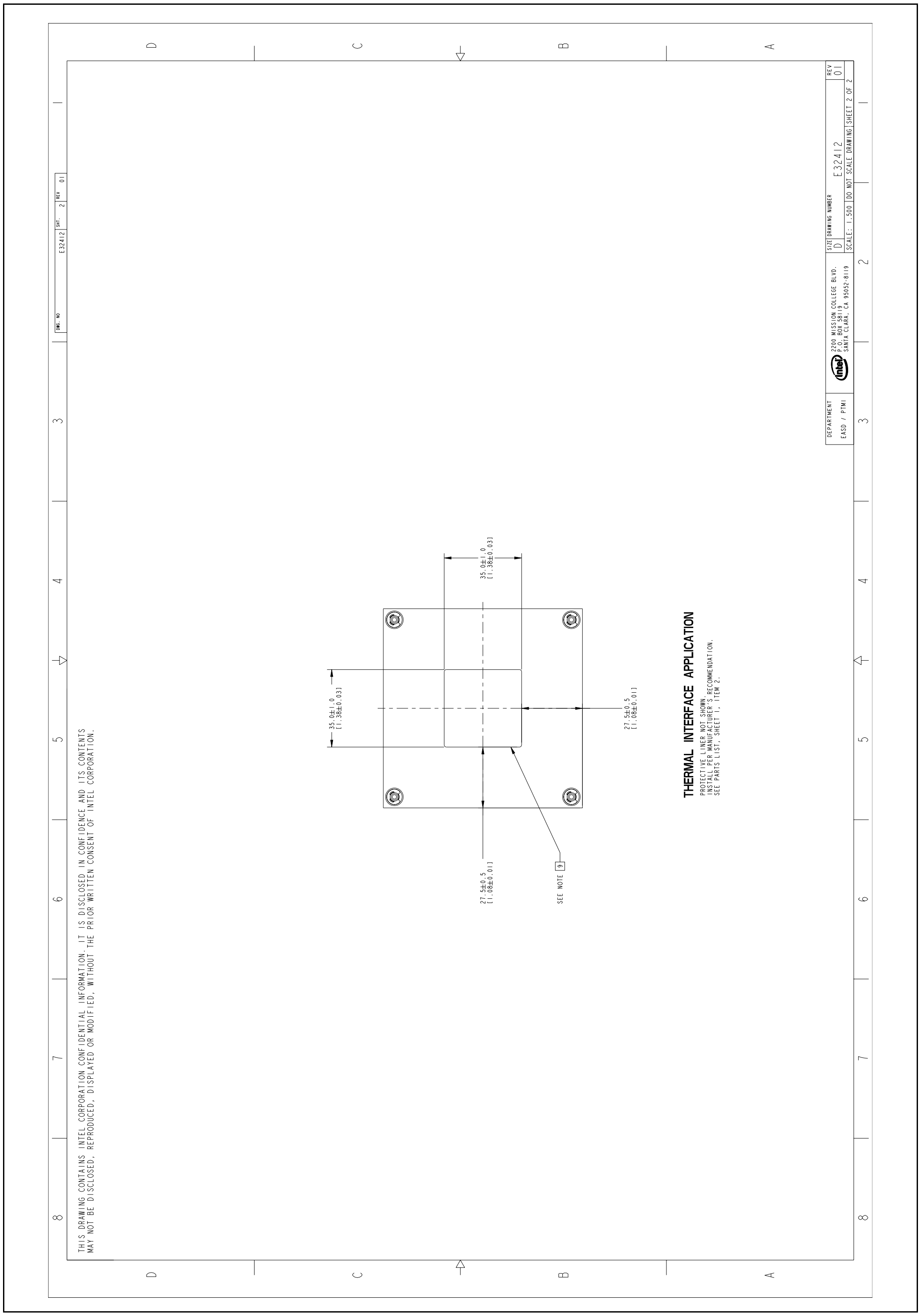


Figure B-26. Tower Reference Heatsink Assembly with TIM (Sheet 2 of 2)



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C Socket Mechanical Drawings

Table C-1 lists the mechanical drawings included in this appendix.

Table C-1. Mechanical Drawing List

Drawing Description	Figure Number
"Socket Mechanical Drawing (Sheet 1 of 4)"	Figure C-1
"Socket Mechanical Drawing (Sheet 2 of 4)"	Figure C-2
"Socket Mechanical Drawing (Sheet 3 of 4)"	Figure C-3
"Socket Mechanical Drawing (Sheet 4 of 4)"	Figure C-4

Figure C-1. Socket Mechanical Drawing (Sheet 1 of 4)

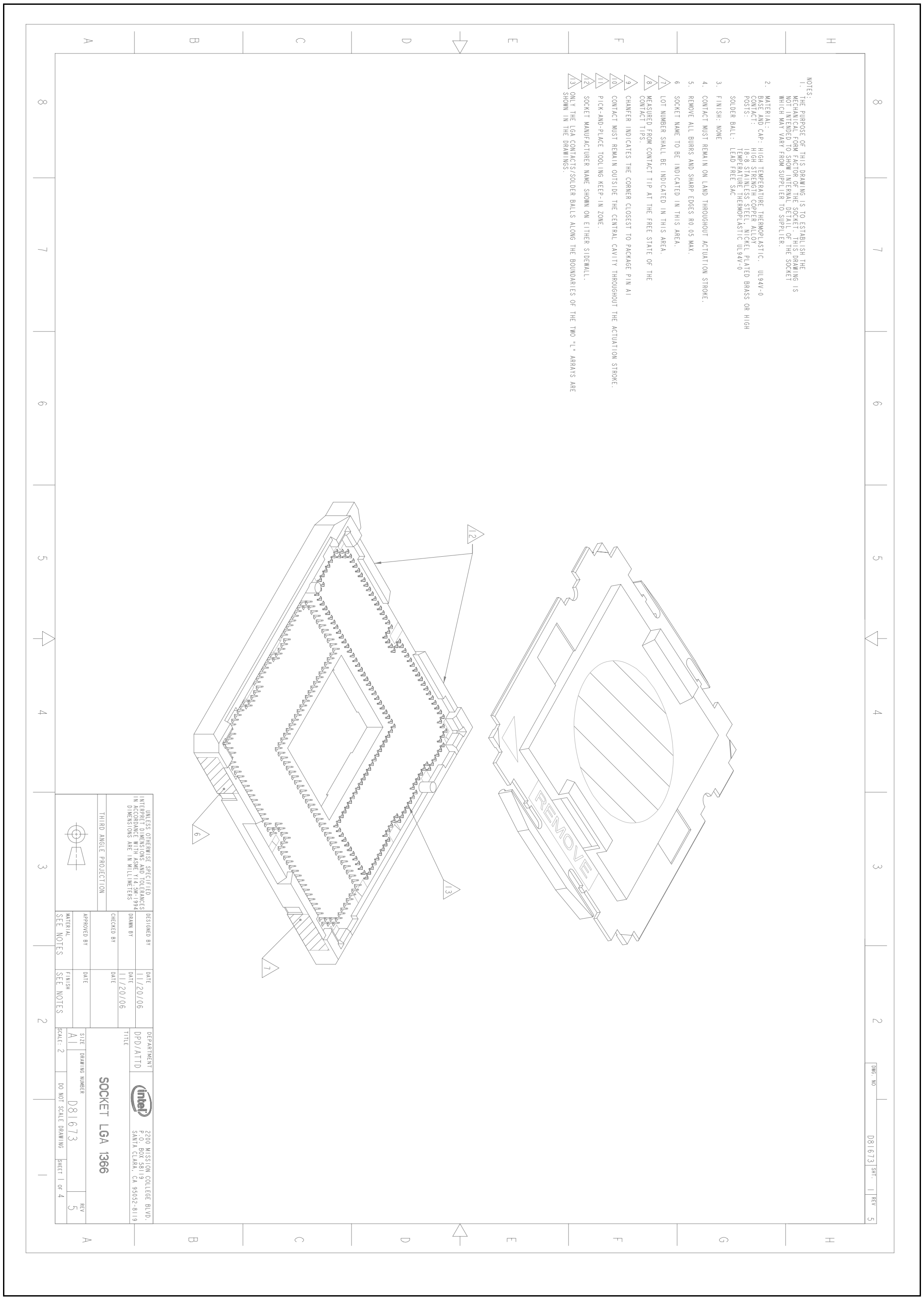


Figure C-2. Socket Mechanical Drawing (Sheet 2 of 4)

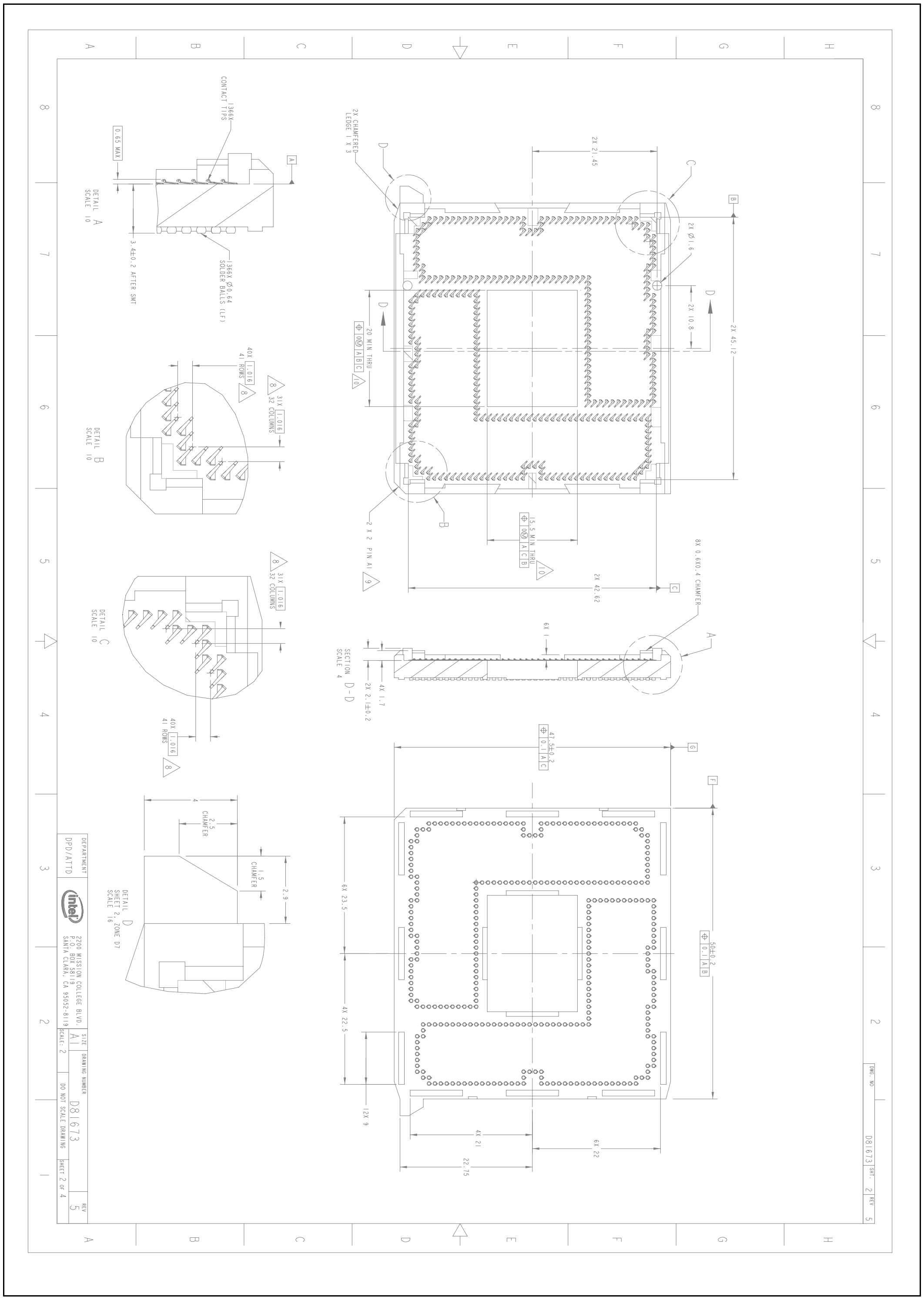


Figure C-3. Socket Mechanical Drawing (Sheet 3 of 4)

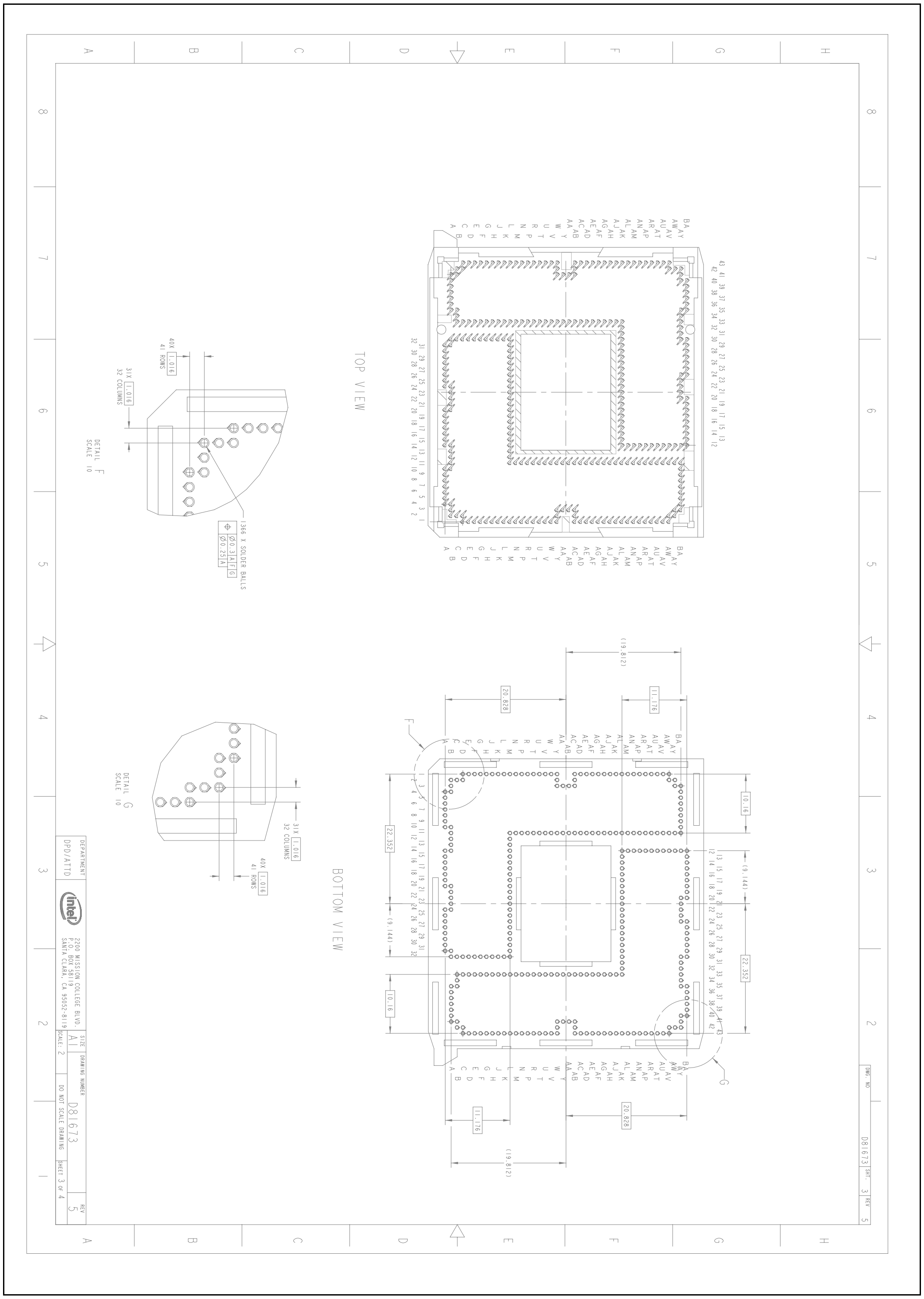
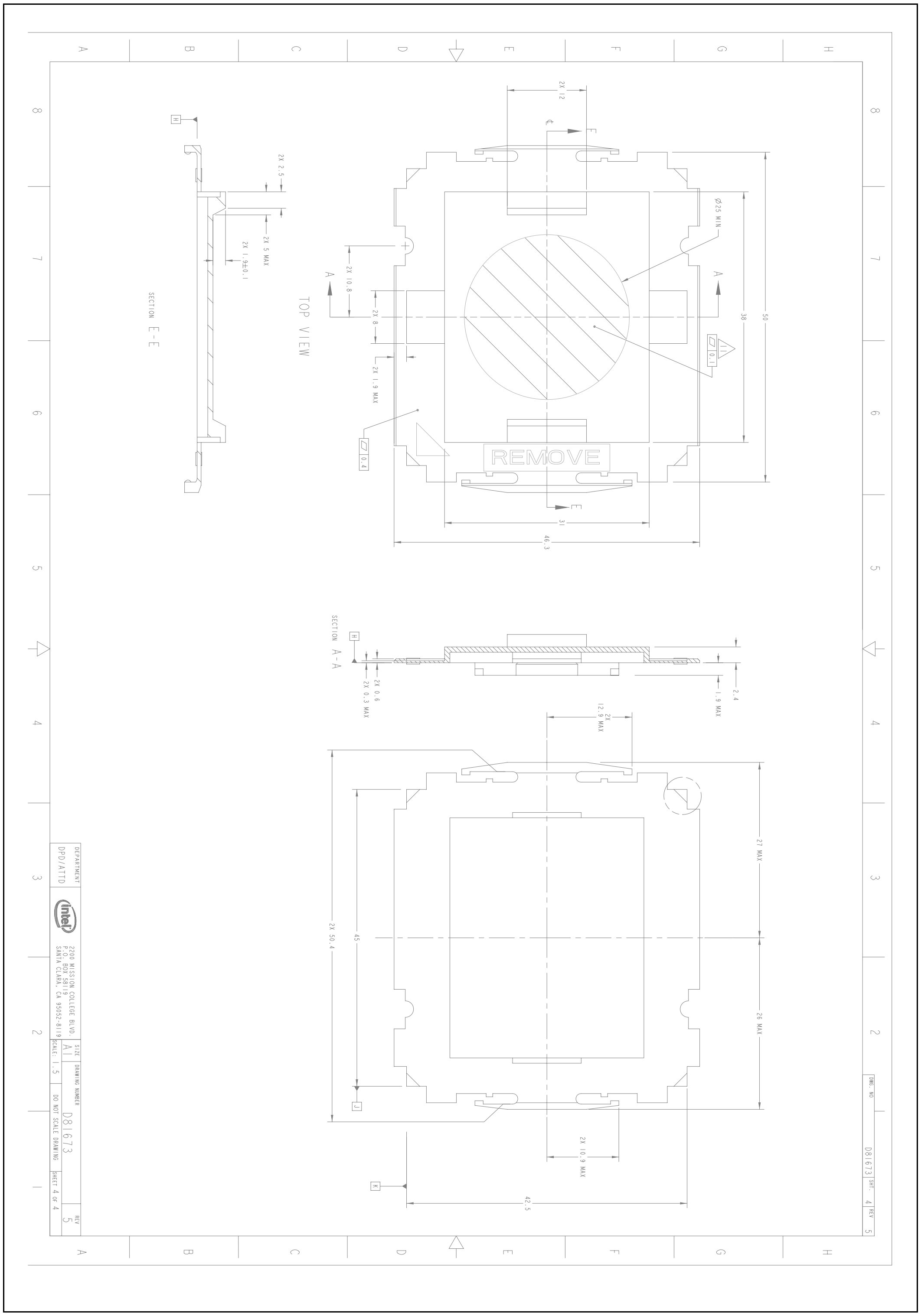


Figure C-4. Socket Mechanical Drawing (Sheet 4 of 4)



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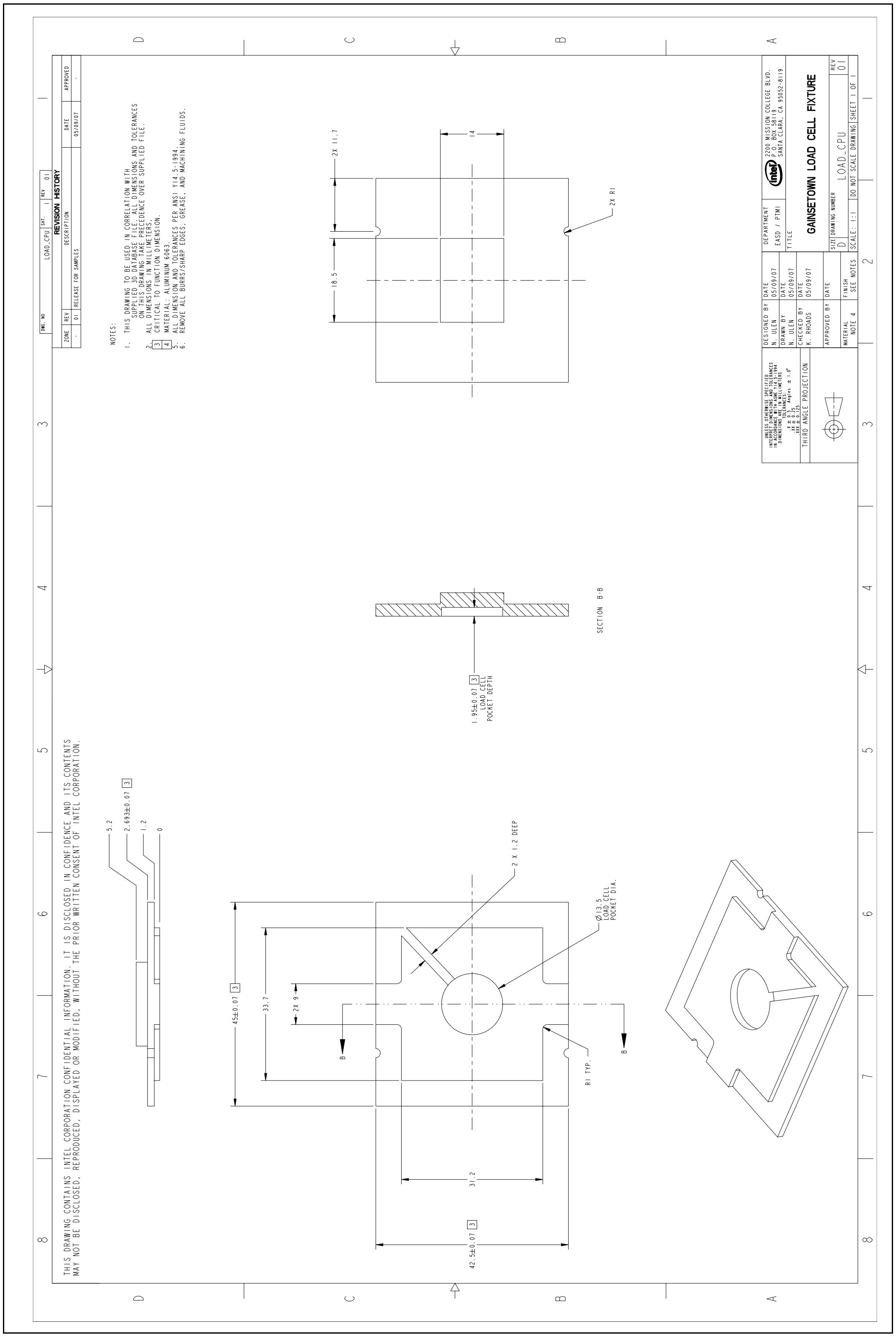
D Heatsink Load Metrology

To ensure compliance to max socket loading value listed in Table 4-3, and to meet the performance targets for Thermal Interface Material in Section 5.3, the Heatsink Static Compressive Load can be assessed using the items listed below:

- HP34970A DAQ
- Omegadyne load cell, 100 lbf max (LCKD-100)
- Test board (0.062") with ILM & back plate installed
- 8 in-lbf pneumatic driver
- Heatsink
- Gainestown Load Cell Fixture (Figure D-1)

Figure D-1. Intel® Xeon® Processor 5500 Series Load Cell Fixture



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E Embedded Thermal Solutions

This section describes the LV processors and Embedded reference heatsinks for NEBS (Network Equipment Building Systems) compliant ATCA (Advanced Telecommunications Computing Architecture) systems. These LV processors are good for any form factor that needs to meet NEBS requirements.

E.1 Performance Targets

Table E-1 provides boundary conditions and performance targets for 1U and ATCA heatsinks. These values are used to generate processor thermal specifications and to provide guidance for heatsink design.

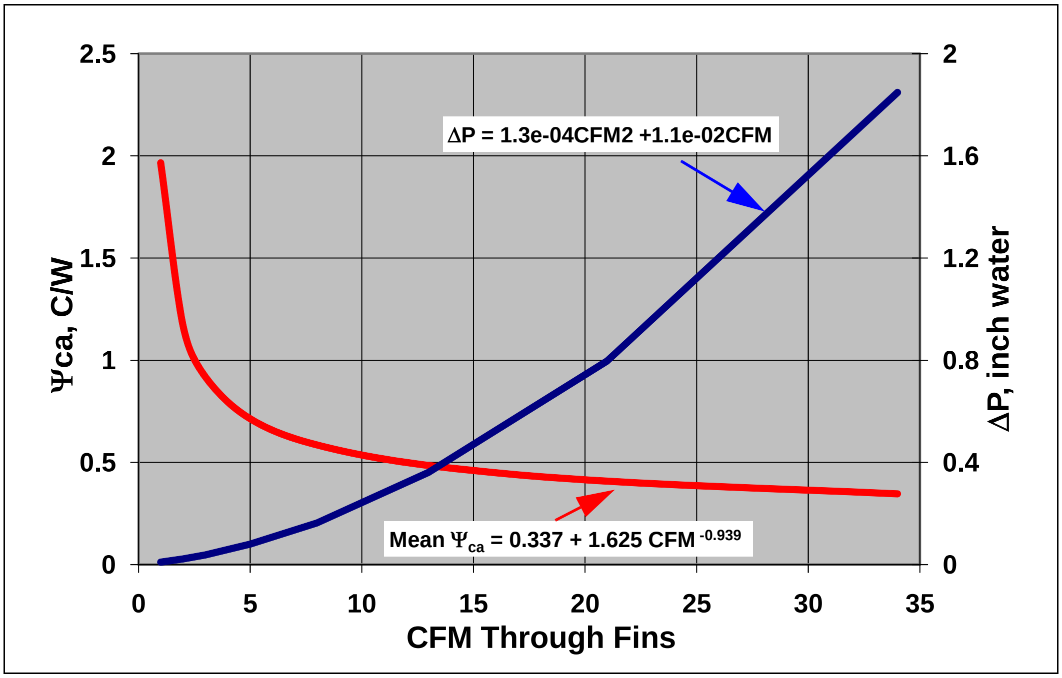
Table E-1. Boundary Conditions and Performance Targets

Parameter	Value	Value
Altitude, system ambient temp Nominal/Short-term	Sea level, 40° C/55C	Sea level, 40° C/55C
TDP	60 W	38 W
T_{LA}[1,4]	51.9/66.9° C	50/65° C
Ψ_{CA}[2]	0.302° C/W	0.532° C/W
System height (form factor)[3]	1U (EEB) or ATCA	ATCA
Heatsink volumetric	1U (90 x 90 x 27) or Custom ATCA (90 x 90 x 13mm + heat exchanger)	ATCA (90 x 90 x 13 mm)
Heatsink technology[5]	Cu base, Cu fins	

Notes:
1. Local ambient temperature of the air entering the heatsink.
2. Max target (mean + 3 sigma + offset) for thermal characterization parameter (Section 5.5.1).
3. Reference system configuration. In a single wide ATCA blade the 60 W processor should be used in single socket only and the 38 W processor can be used in dual socket.
4. Local Ambient Temperature written 50/65° C means 50° C under Nominal conditions but 65° C is allowed for Short-Term NEBS excursions.
5. Passive heatsinks with TIM.
6. See Section 5.1 for standard 1U solutions that do not need to meet NEBS.

Detailed drawings for the ATCA reference heatsink can be found in Section E.3. Table E-1 above specifies Ψ_{CA} and pressure drop targets and Figure E-1 below shows Ψ_{CA} and pressure drop for the ATCA heatsink versus the airflow provided. Best-fit equations are provided to prevent errors associated with reading the graph.

Figure E-1. ATCA Heatsink Performance Curves



Other LGA1366 compatible thermal solutions may work with the same retention.

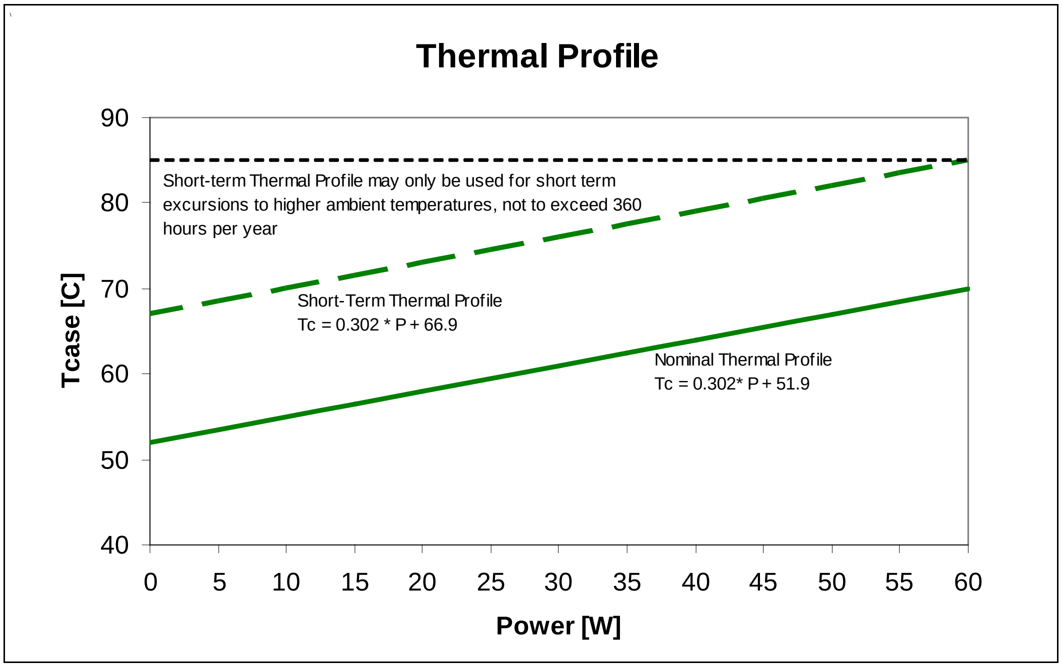
E.2 Thermal Design Guidelines

E.2.1 NEBS Thermal Profile

Processors that offer a NEBS compliant thermal profile are specified in the *Intel® Xeon® Processor 5500 Series Datasheet, Volume 1*.

NEBS thermal profiles help relieve thermal constraints for Short-Term NEBS conditions. To help reliability, processors must meet the nominal thermal profile under standard operating conditions and can only rise up to the Short-Term spec for NEBS excursions (see Figure E-2). The definition of Short-Term time is clearly defined for NEBS Level 3 conditions but the key is that it cannot be longer than 360 hours per year.

Figure E-2. NEBS Thermal Profile



Notes:
1.) The thermal specifications shown in this graph are for reference only. See the Intel® Xeon® Processor 5500 Series Datasheet, Volume 1 for the Thermal Profile specifications. In case of conflict, the data in the datasheet supersedes any data in this figure.
2.) The Nominal Thermal Profile must be used for all normal operating conditions, or for products that do not require NEBS Level 3 compliance.
3.) The Short-Term Thermal Profile may only be used for short-term excursions to higher ambient operating temperatures, not to exceed 360 hours per year as compliant with NEBS Level 3.
4.) Implementation of either thermal profile should result in virtually no TCC activation.
5.) Utilization of a thermal solution that exceeds the Short-Term Thermal Profile, or which operates at the Short-Term Thermal Profile for a duration longer than the limits specified in Note 3 above, do not meet the processor thermal specifications and may result in permanent damage to the processor.

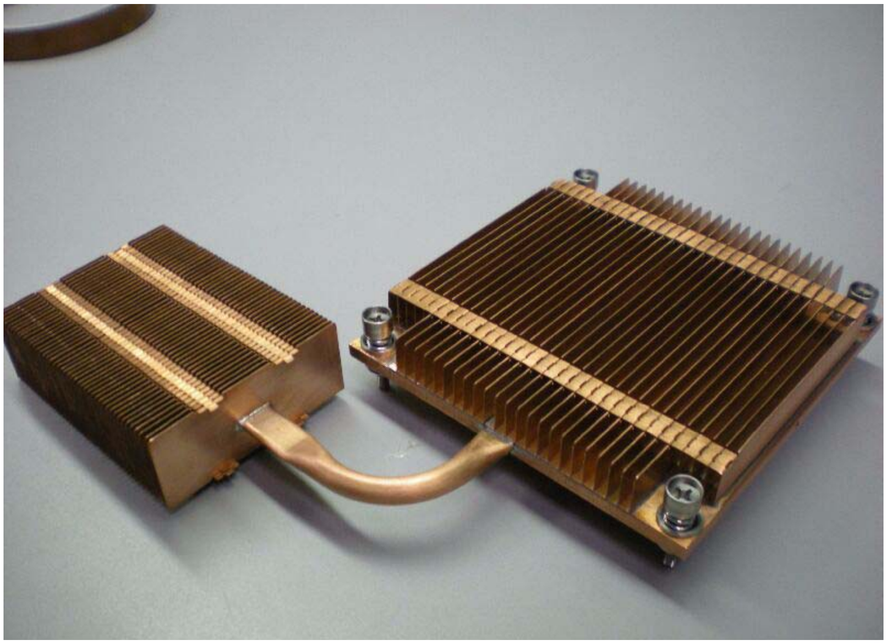
E.2.2 Custom Heat Sinks For UP ATCA

The Embedded specific 60W SKU is targeted for NEBS compliant 1U+ systems and UP ATCA configurations with custom thermal solutions. In order to cool this part in a single wide ATCA slot, a custom thermal solution will be required. Since solutions like this will be very configuration specific, this heat sink was not fully designed with retention and keep-out definitions.

In order to cool the additional power of a 60W processor in ATCA, the heat sink volume was increased. The assumption was that the heat sink could not grow wider because of VR and Memory placement, so a Remote Heat Exchanger (RHE) was used. The RHE is attached to the main heat sink with a heat pipe. The RHE gives additional convective surface area and gives the thermal solution access to more air. Samples of the following design were ordered and tested for thermal performance only.

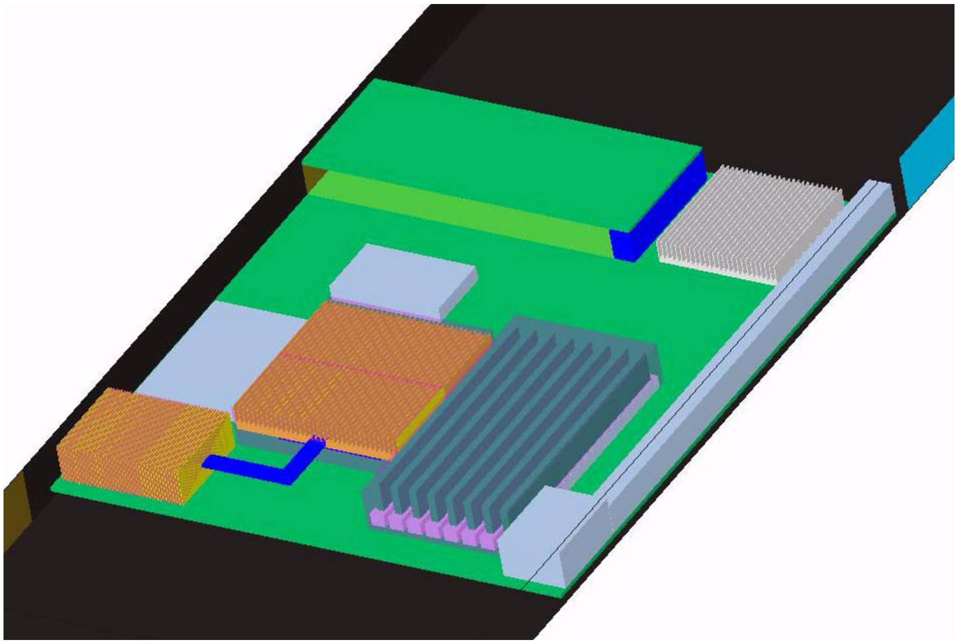
Flotherm analysis shows that the following design can cool an LGA1366 TTV in an ATCA blade at 30CFM. The heat sink Ψca would be 0.50C/W at 55C ambient which falls below the thermal profile for the 60W processor.

Figure E-3. UP ATCA Thermal Solution



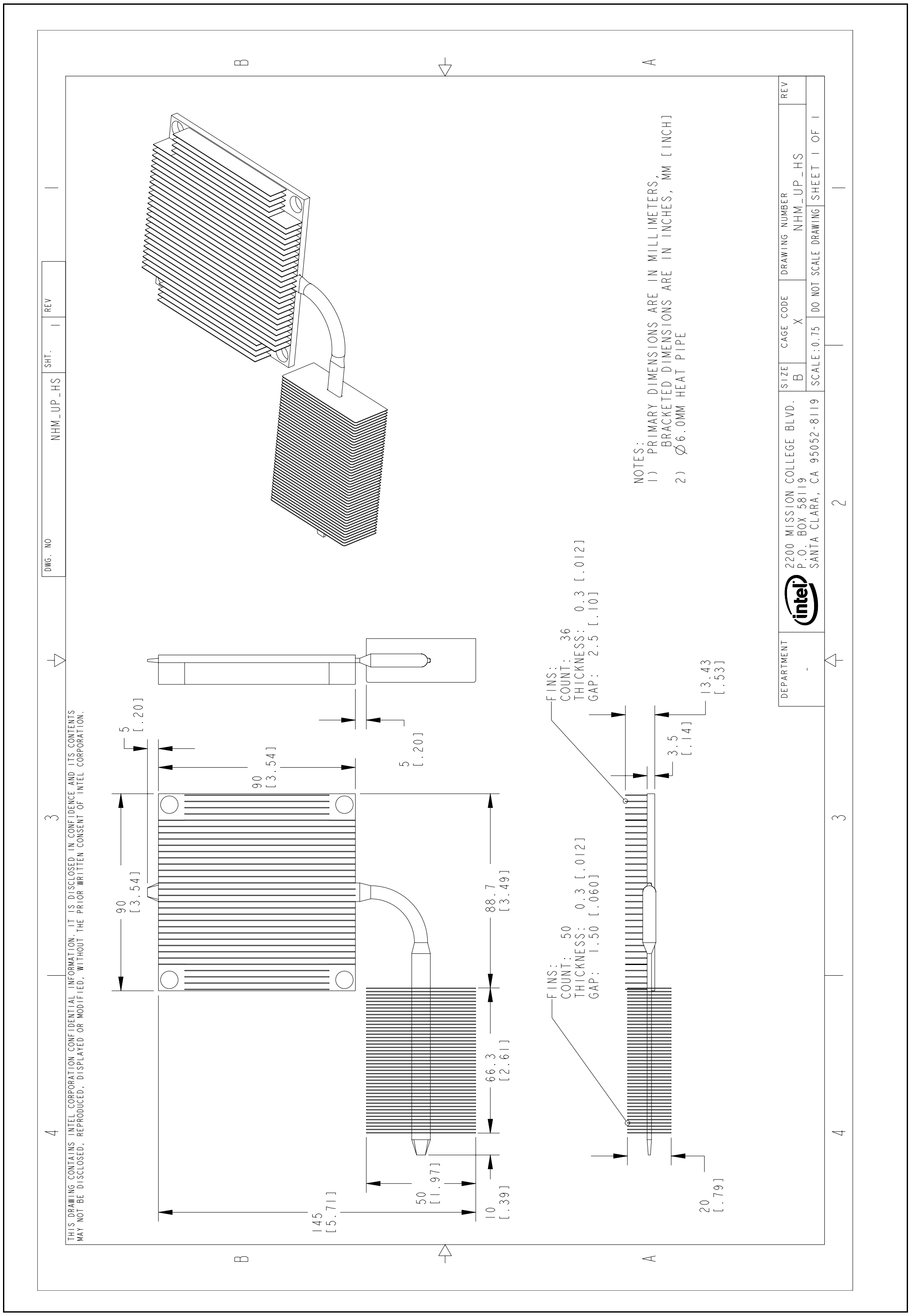
Notes: Thermal sample only, retention not production ready.

Figure E-4. UP ATCA System Layout



Notes: Heat sink should be optimized for the layout.

Figure E-5. UP ATCA Heat Sink Drawing



E.3 Mechanical Drawings and Supplier Information

See Appendix B for retention and keep out drawings.

The part number below represent Intel reference designs for a DP ATCA heatsink. Customer implementation of these components may be unique and require validation by the customer. Customers can obtain these components directly from the supplier below.

Table E-2. Embedded Heatsink Component Suppliers

Assembly	Component	Description	Supplier PN	Supplier Contact Info
Assembly, Heat Sink, Nehalem-EP, ATCA	**ATCA Reference heatsink** Intel P/N E65918-001	ATCA Copper Fin, Copper Base	Fujikura HSA-7901	Fujikura America Ash Ooe a_ooe@fujikura.com 408-748-6991 Fujikura Taiwan Branch Yao-Hsien Huang yeohsien@fujikuratw.com.tw 886(2)8788-4959

Table E-3. Mechanical Drawings List

Parameter	Value
ATCA Reference Heat Sink Assembly (Sheet 1 of 2)	Figure E-6
ATCA Reference Heat Sink Assembly (Sheet 2 of 2)	Figure E-7
ATCA Reference Heatsink Fin and Base (Sheet 1 of 2)	Figure E-8
ATCA Reference Heatsink Fin and Base (Sheet 2 of 2)	Figure E-9

Figure E-6. ATCA Reference Heat Sink Assembly (Sheet 1 of 2)

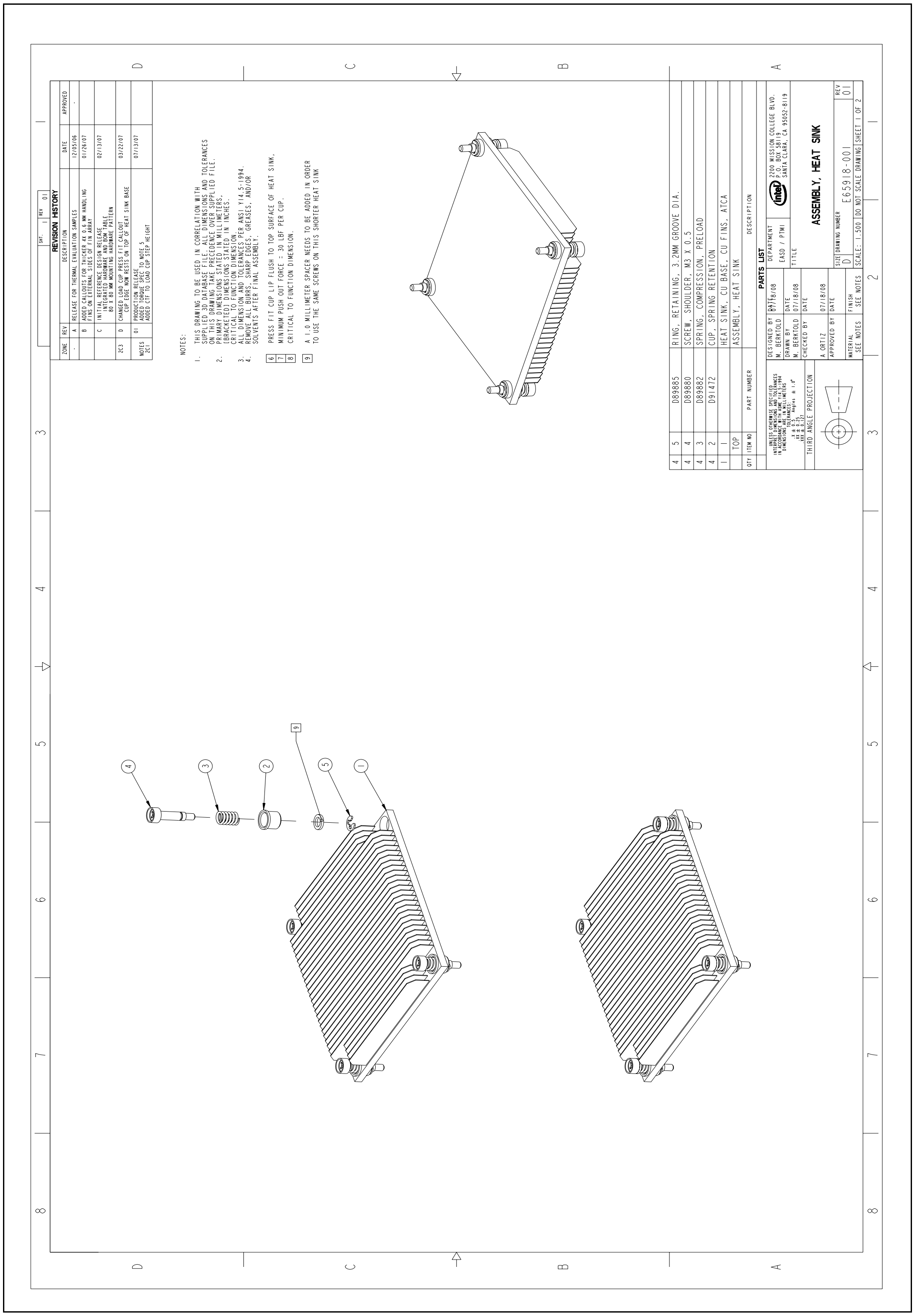


Figure E-7. ATCA Reference Heat Sink Assembly (Sheet 2 of 2)

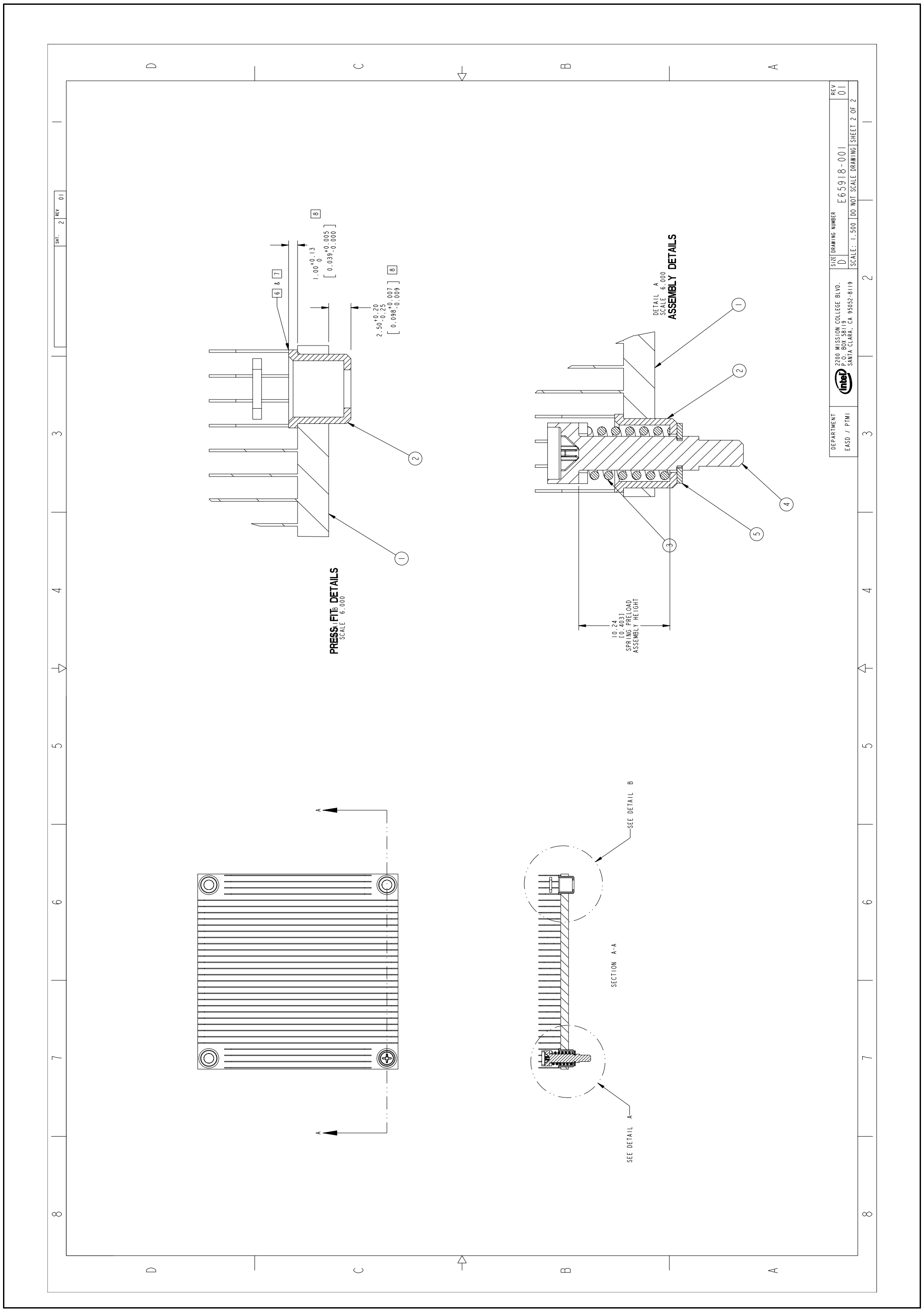


Figure E-8. ATCA Reference Heatsink Fin and Base (Sheet 1 of 2)

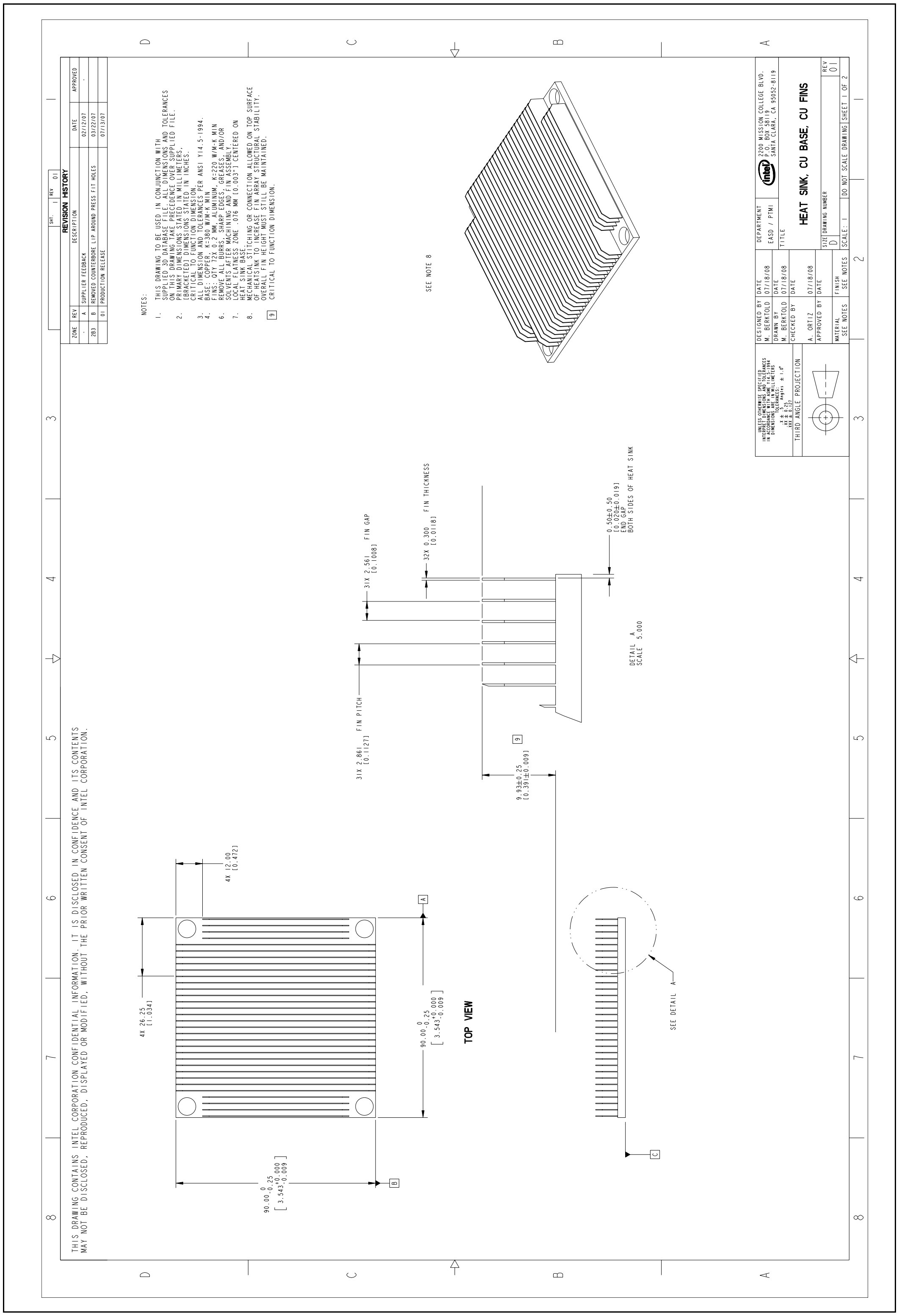
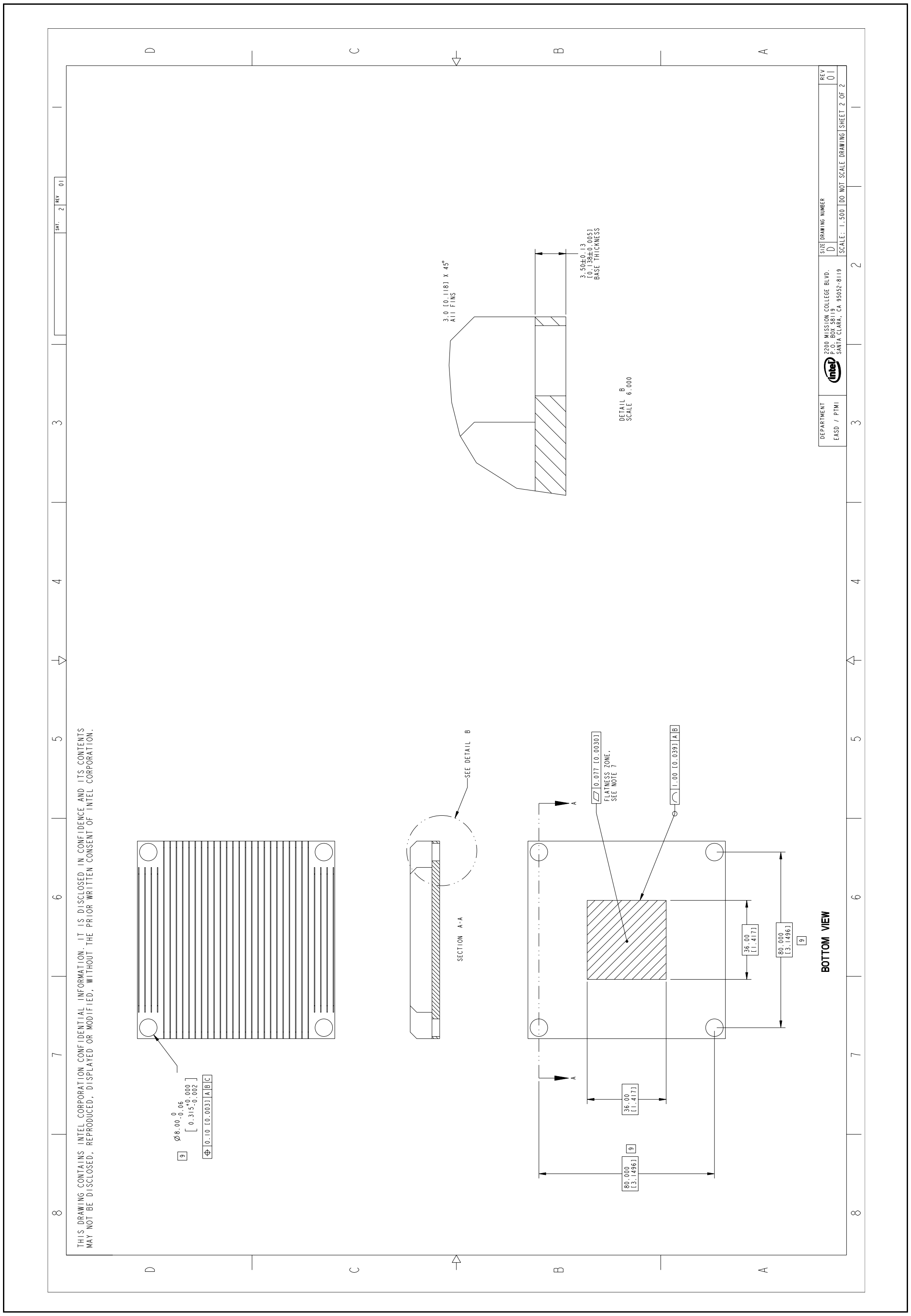


Figure E-9. ATCA Reference Heatsink Fin and Base (Sheet 2 of 2)



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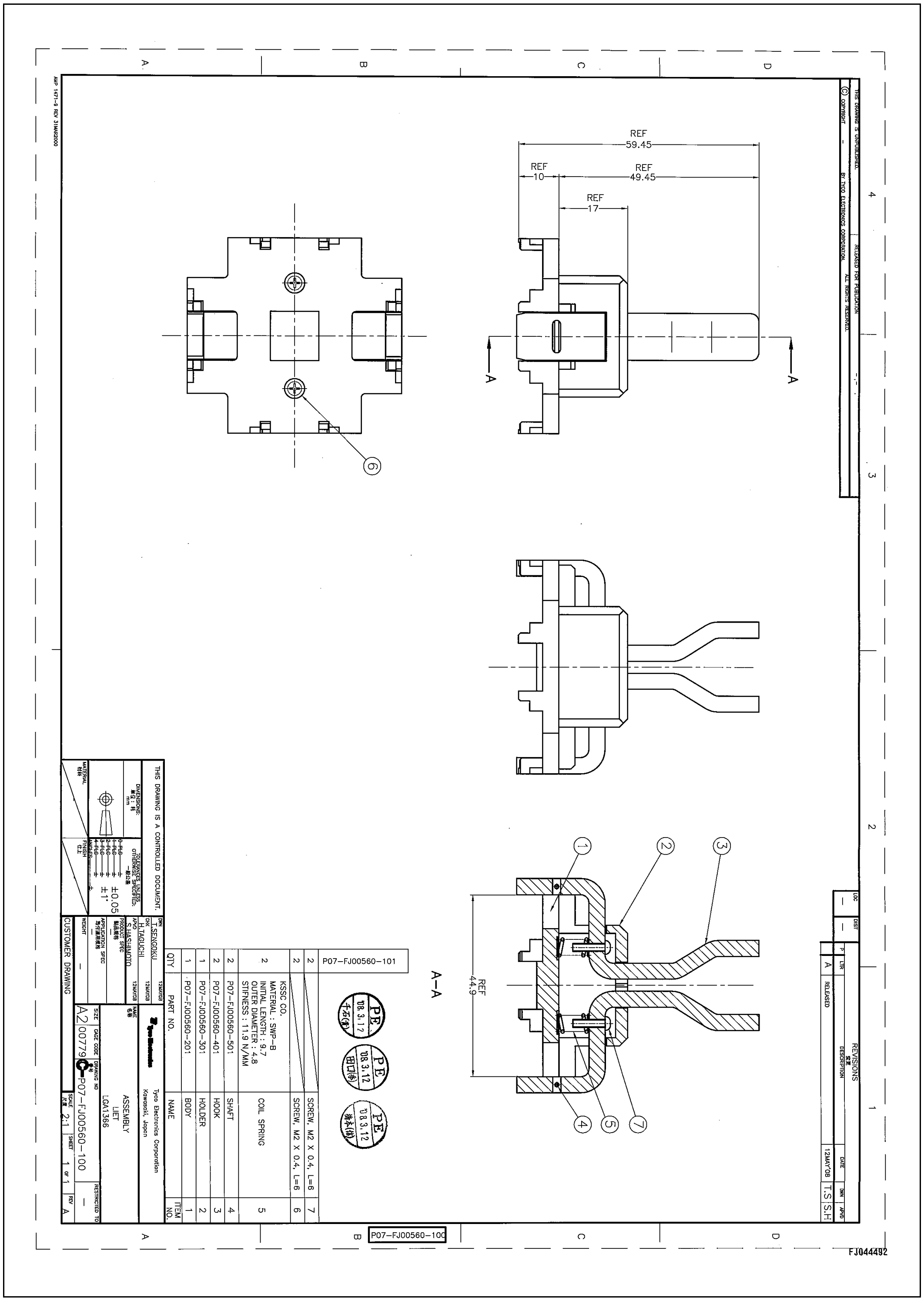
F Processor Installation Tool

The following optional tool is designed to provide mechanical assistance during processor installation and removal.

Contact the supplier for availability:

Billy Hsieh
billy.hsieh@tycoelectronics.com
+81 44 844 8292

Figure F-1. Processor Installation Tool



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